Assessment of industrial performance and the relationship between skill, technology and input-output indicators in Sudan

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By Samia Satti Osman Mohamed Nour

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Abstract

This paper examines the industrial performance indicators and the relationships between skill indicators; between skill, upskilling, technology and input-output indicators in Sudan. Our findings are consistent with the stylized facts in the new growth literature, concerning the correlation between skill indicators: education, experience and wages and also concerning the positive complementary relationships between technology, skill and upskilling. Different from the Sudanese literature, a novel element in our analysis is that we use a new primary data from the firm survey (2010) and we provide a new contribution and fill the gap in the Sudanese literature by examining the industrial performance indicators defined by three different sets of economic and productivity indicators, activity indicators and profitability indicators in Sudan. One advantage and interesting element in our analysis in this paper is that we confirm three hypotheses on the relationships between skill indicators; between skill, upskilling, technology and input-output indicators and industrial performance indicators using new primary data from the firm survey (2010) in Sudan. We verify our first hypothesis that irrespective of the observed differences across the industrial firms, the low skill levels – due to high share of unskilled workers – lead to skills mismatch and most probably contribute to decline of labour productivity and industrial performance indicators. We confirm our second hypothesis that an increase in skill levels and firm size lead to improved relationships between actual and required education and experience; between actual education, experience and wages; and between skill, upskilling and technology (ICT) and also improved industrial performance indicators. We also support our third hypothesis concerning the inconclusive relationships between new technology (the use of ICT) and input-output indicators at the micro/firm level. Finally, we provide a new contribution to the Sudanese literature, since we explain that the performance of the industrial firms is most probably immensely undermined by the shortage of skilled workers and also by the lack of entrepreneur perspective. We recommend further efforts to be made to improve adequate availability of skilled workers and commitment to entrepreneur perspective for improvement of labour productivity, industrial performance and therefore, economic growth and development in Sudan.

Keywords: Industrial performance, skill, technology, input-output, firm size, industry, Sudan

JEL classification: J24, L10, L20, L25, L60, O12, O15, O30.

[1] Corresponding Author: Dr. Samia Satti Osman Mohamed Nour, Visiting Research Fellow – University of Maastricht, School of Business and Economics, UNU-MERIT, Maastricht, the Netherlands; and Assistant Professor of Economics, Economics Department, Faculty of Economic and Social Studies, Khartoum University, Khartoum, Sudan. E-mail: samiasatti@yahoo.com; samia_satti@hotmail.com. The first draft of this paper was originally prepared within the author's research project "Technological Change and Skill Development: the case of Sudan" during the author's time as a visiting research fellow at the University of Maastricht, School of Business and Economics, UNU-MERIT, Maastricht, the Netherlands. The author gratefully acknowledges the Arab Fund for Economic and Social Development, Kuwait, for research grant and fellowship and University of Maastricht, School of Business and Economics, UNU-MERIT for the good hospitality during her visiting research fellowship. The author would like to gratefully thank Prof. Joan Muysken and Dr. Hisham Mohamed Hassan for their useful comments on the first draft of this paper. All the usual disclaimers apply.

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1. Introduction

Several studies in the literature confirm the importance of industrialization, human capital, S&T, and technical progress for stimulating economic growth and human welfare and identify industrial innovation as the engine of growth (Romer, 1990; Freeman and Soete, 1997).

Other studies in the literature argue that the rapid progress in industrialization, technological innovation, information and communication technologies and globalization brought many benefits but simultaneously also caused increasing development gap between developed and developing countries and made it harder for the developing countries to bridge the already widening development gap between the developed and developing countries. This adds to the already existing critical problems of industrialization in the developing countries including the lack of material, energy, financial and human resources, shortage of skilled workers, poor organizational management, dependence on obsolete machines, poor technological capabilities, poor sectoral system of innovation, lack of incentives, lack of favorable environment, poor protection for domestic industries and lack of marketing opportunity because of low competitiveness in the local, regional and international markets.

Apart from the literature on the importance of the industrial innovation and the problems of industrialization in the developing countries, it is useful to explain the importance of assessment of the industrial performance. From the traditional microeconomics theory of the firm we already know the standard assumption assumed that all firms are following rational decision-making, and will produce at the profit-maximizing output. From the traditional microeconomics theory of the firm we also learn that the duality theorem implies the common presence of the conditions of profit-maximization and cost-minimization. It assumed that all firms aim to achieve profit maximization by finding the input combinations that would produce a maximum levels of output and maximum levels of profit or alternatively to achieve the cost-minimization by finding the input combinations that would produce a given level of output at minimum cost. Given this assumption, the rational decision-making also implies achievement of efficient allocation of the relatively scarce economic resources and inputs. This background guides us to interpret the importance of assessment of industrial performance. From economic perspective the concept performance evaluation of the industrial firms implies judgment and assessment of successful achievement of the ultimate objectives of efficient use of economic resources for achievement of good and improved performance in the industrial firms by comparing the actual attained outcomes with the previous planned objectives. Thus, evaluation of performance is useful for enabling industrial firms to examine the real performance, follow-up implementation phases, evaluation of

results, investigation of problems and sound solutions for problems. Assessment of industrial performance indicators across industrial firms can be measured by several sets of indicators; these include for instance, three different sets of economic and productivity indicators, activity indicators and profitability indicators. For instance, the definition of industrial performance includes the first set of economic indicators that defined by three indicators including the degree of industrialization, capital intensity level and a set of productivity indicators such as labour productivity; capital productivity; fixed capital productivity; wage productivity and raw materials productivity indicators. In addition, the industrial performance is defined by the second set of activity indicators including capital and fixed capital turnover ratios and the third set of profitability indicators including the rate of return on capital or profit/capital ratio and profit margin or profit/sales ratio (cf. Al-Quraishi, 2005: 249-277).

Based on the above background, the aim of this paper is to broaden our earlier analysis in Nour (2011) by providing an in-depth analysis of industrial performance indicators, skill and technology indicators and the relationship between them and the implications of the prevalence of low-skilled workers at the micro level. Moreover, we examine the relationships between: skill indicators (education/actual education and occupation/required education respectively and experience) and average wages; between skill, upskilling (spending on ICT training) and technology (spending on ICT); and between technology (spending on ICT) and input-output indicators across firms. We also compare the relevance of our results to the findings concerning these relationships in the new growth literature. We examine our first hypothesis that, irrespective of the observed differences across the industrial firms, high skill requirements and low skill levels – due to high share of unskilled workers – lead to skills mismatch and most probably also contribute to industrial performance indicators and productivity decline across the industrial firms in Sudan. We investigate our second hypothesis that an increase in skill levels and firm size lead to improved relationships between actual and required education and experience; between actual education, experience and wages; and between skill, upskilling and technology (ICT). We examine our third hypothesis concerning the inconclusive relationships between technology (the use of ICT) and input-output indicators at the micro/firm level.

Our findings are broadly consistent with the stylized facts in the new growth literature, concerning the correlation between education, experience and wages and also concerning the positive complementary relationships between technology, skill and upskilling. In addition, our results concur both with the general literature that defines both skill and technology in relation to firm characteristics (size and industry), and also the recent literature highlighting the growing effects of new technologies, especially ICT diffusion.

Different from the Sudanese literature, a novel element in our analysis is that we use a new primary data from the firm survey (2010) and we provide a new contribution and fill the

gap in the Sudanese literature by examining the value and trend of industrial performance indicators that we measure by three different sets of economic and productivity indicators, activity indicators and profitability indicators across industrial firms in Sudan using the definition of industrial performance indicators used in the literature (Al-Quraishi, 2005). We assess the industrial performance by the first set of economic indicators including the degree of industrialization, capital intensity level and a set of productivity (labour productivity; capital productivity; fixed capital productivity; wage productivity and raw materials productivity indicators). In addition, we assess the industrial performance by the second set of activity indicators including both capital and fixed capital turnover ratios and the third set of profitability indicators including the rate of return on labour or profit/labour ratio, the rate of return on capital or profit/capital ratio and profit margin or profit/sales ratio. Our results imply that in most cases an increase in skill level -share of high skill in total employment- firm size and industry most probably leads to an improvement in most of industrial performance indicators. Compared to the Sudanese literature, we provide a new contribution to improve the understanding by explaining the important potential contribution of the industrial sector in enhancing economic development in Sudan from the perspective of the industrial firms based on our results from the firm survey (2010). Our results from the firm survey (2010) are consistent with the results in the developing countries and Sudanese literature that indicate several problems of industrialisation in Sudan (El-Sayed, 1998 and Abd-Alsalam, 2006) similar to those reported in typically developing countries (Ismail, 2007). Different from the studies in the Sudanese literature (El-Sayed, 1998 and Abd-Alsalam, 2006) that provide somewhat general overview concerning the problems of industrialisation in Sudan, an interesting and novel element in our analysis is that we use a new primary data based on the firm survey (2010) and we present a new interpretation of the main problems of industrialisation in Sudan from the perspective of different industrial firms considering the opinions of a more diversified sample of industrial firms. Moreover, we provide a new contribution to Sudanese literature, since our results from the firm survey (2010) show that the low skill levels and lack of entrepreneur perspective may contribute to the decline in labour productivity (in physical term: output/labour ratio) and in industrial performance indicators that we define by three different sets of economic and productivity indicators, activity indicators and profitability indicators across firms over the period (2005-2008). Finally, we provide a new contribution to the Sudanese literature, since we recognize the importance of improving skill level or adequate availability of skilled workers and commitment to entrepreneur perspective for improvement of labour productivity, industrial performance and therefore, economic growth and development in Sudan.

The rest of this paper is organized as follows: Section 2 provides background about the industrial sector in Sudan. Section 3 defines the variables used in our analysis and the general

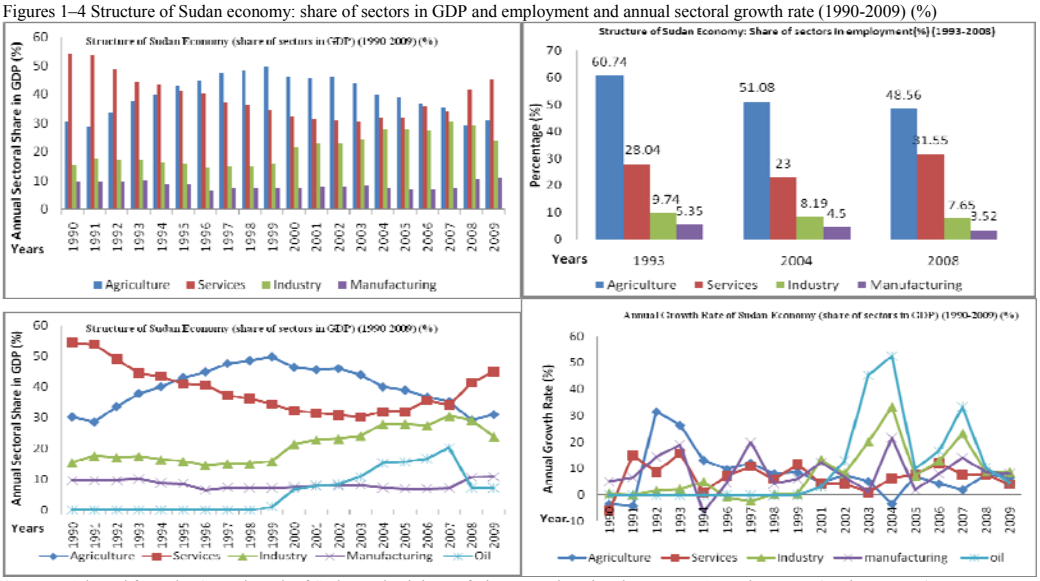
characteristics of firms. Section 4 examines our first hypotheses and discusses differences in prevalent skill levels and requirements and the implications of low skill levels on skills mismatch, industrial performance indicators and productivity decline across firms. Section 5 investigates our second hypothesis on the relationships between actual and required education, experience and wages. Section 6 examines our second and third hypotheses on the relationships between skill, technology (spending on ICT) and upskilling (spending on ICT training) and between technology (ICT) and input-output indicators. Section 7 concludes.

2. The Importance of the Industrial sector in Sudan

Prior to investigating the industrial performance and the relationships between skill, upskilling, technology and input-output indicators across firms, it is useful to show background about the industrial sector because understanding the importance of the industry can help in supporting potential contribution of industry in enhancing economic growth and development in Sudan.

Beginning with the general structure of Sudan economy One stylized fact which we explained in Nour (2011) and in Figures 1-4 below is that the structure of Sudan economy shows the importance of the agricultural sector (48%, 31.1%, 27%) and services sector (36%, 45%, 37%) compared to the industrial sector (10%, 23.9%, 36%) and manufacturing sector (3.52%, 10.8%, 6%) in terms of the share in total employment (2008), total GDP (2009) and value added as a percentage of GDP (2009) respectively, further to the minor contribution of the industrial sector to total exports in Sudan (17%) (2001)- see Figures 1-4 above.[2] In addition to the minor contribution of the industry value added annual growth (15%).[3]

Figures 1–4 Structure of Sudan economy: share of sectors in GDP and employment and annual sectoral growth rate (1990-2009) (%)



Sources: Adapted from the Central Bank of Sudan and Ministry of Finance and National Economy Annual Reports (Various Issues)

[2] See for instance, Sudan Central Bureau of Statistics Population Census Data (2010): 5th Sudan Population and Housing Census (2008) for the data on the distribution and sectoral share in total employment. See also the Central Bank of Sudan Annual Report (2009) for the distribution and sectoral share in total GDP. See also World Development Indicators Database (April 2010: accessed on December 01, 2010) for data on the distribution and sectoral share in value added as a percentage of GDP. See also Ministry of Industry Comprehensive Industrial Survey (2005) for data on the share of industry in Sudan's total exports (2001).

[3] See for instance, the World Development Indicators Database, April (2005): accessed on December 01, 2005.

Moreover, in 2002, Sudan (8.26 and 28) has been lagging much behind compared to North Africa (15.57 and 28) and developing countries (20.3 and 908) in terms of both the manufacturing value added as percentage of GDP and manufacturing value added per capita respectively.[4] Despite the minor contribution of the industrial sector in Sudan economy, this paper and the firm survey focus on the industrial sector, because of the importance of the industrial sector in enhancing both technological development and economic growth for any country. Moreover, for the case of Sudan, for many reasons, the industrial sector has the potential to play a significant role in enhancing economic and social development, increasing the value added, strengthening and fostering the capabilities of the national economy to contribute into the development and improvement of the living conditions in Sudan. Notably, the first reason is that the abundant natural resources including agricultural resources, animal resources, fisheries resources, forests resources, land and water resources all have the potential to form the basis for the manufacturing industrial development in Sudan. For instance, since long, the agricultural sector is a leading sector that has often supported the manufacturing industries in Sudan; agricultural crops have often provided the industrial sector with a high ratio of its inputs. For instance, textile industries benefited from the cultivated areas in cotton and food industries benefited from the high production of oil seeds particularly vegetable oil. Moreover, the fish and animal resources and their products are being used as inputs in food industries and also animal hides and skins are being used as inputs in the manufacturing of leather and leather products. In addition, the forest natural resources and forestry and its products form an important input for manufacturing industries related to forestry products, for example, manufacturing of wood and wood products, manufacturing of furniture, manufacturing of other house utensils, moreover, wood can be used in building poles and telephone poles. In addition, the second reason is that the geology of Sudan indicates abundant mineral resources such as iron, cooper, chrome, manganese, gold, silicon, lime stone, marble, gypsum, mica, natural gas all of which have the potential to promote extractive industries in Sudan. Moreover, the third reason is that the industrial sector is composed of several sub-sectors and as such it has the potential to produce diversified products to cover the diversified needs of local population, for instance, this includes the needs from food industries, spinning and textile industries; leather industries; chemical and pharmaceutical industries; oil and soap industries; engineering industries; building materials and refractories and printing and packing. Furthermore, the fourth reason is the relatively high installed capacity of the industrial sector which enables Sudan to enjoy the third largest industrial basis in Africa after South Africa and Egypt.[5] For instance, the installed capacities in the industrial sector are relatively higher than the national needs, thereby, it has the potential to produce considerable surplus for exports to

[4] See for instance, UNDP (2006), p. 82.
[5] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

neighboring countries if full capacities can be exploited, however, so far the utilized capacities are low ranged between 20%-25%. Moreover, the fifth reason is that the rate of returns on investment in capital in the industrial sector (34%) is relatively high compared to other sectors in Sudan economy.[6] Consequently, it is not surprising that the industrial sector (including energy and mining and oil) attracts about 83% of total foreign investment inflows to Sudan, although the majority of foreign investment is concentrated in extractive oil and energy and mining sector (73%) and minority in the manufacturing industry (10%) as we explained in Nour (2011). The main limitation of our selection was that the Sudan does not report the highest performance within the Arab region with respect to industrial performance and both skill and technology indicators.[7] In addition, the Sudan has one of the lowest per capita manufacturing product in the Arab region, North Africa and developing countries as we explained above. Apart from this limitation our results remain useful to improve understanding and provide useful insights from both analytical and policy perspectives to improve the industrial performance and therefore economic growth in Sudan.

The firm survey covers small, medium and large size firms working in four industries in the manufacturing sector: the food, textile, chemical and metal industries.[8] The selection of these industries was based on the following reasons: First, the argument for both upskilling and technological upgrading is promising in these sectors and can be used to reduce the poverty and unemployment problems in the country. Second, the strategic importance of these sectors in creating forward and backward linkages and spin-off effects to other sectors/industries. Third, the food and textile industries represent an agro-industry based manufactured products that benefited from the comparative advantage of the rich agricultural resources in the Sudan, while the chemical and metal sectors have the potential to produce an energy intensive use products benefiting from the comparative advantage of the abundant and cheapest mineral and energy sources particularly petroleum in the Sudan. Fourth, the potential for product diversification in these sectors is promising. Fifth, the important contribution of these sectors in the manufacturing sector, for instance, in terms of gross output, gross value added, capital investment, total labour force, total exports, total imports and total number of industrial establishments in the manufacturing sector. For instance, in 2001, the contribution

[6] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

[7] Our analysis in Nour (2010) illustrates that Sudan shows insufficient and poor performance and Sudan is falling behind compared to other Arab countries in terms of skill-technology indicators, technological performance and technology indicators as measured by expenditures on R&D as a percentage of GDP, application to patents, the use of ICT and the use of Internet indicators. We find that Sudan shows poor performance compared to other Arab countries in terms of skill indicators or indices – as measured by the Harbison Myers index, technical enrolment index and engineering enrolment index. Sudan shows poor performance compared to other Arab countries in terms of educational performance as measured by educational enrolment, gross enrolment ratio in tertiary education, school life expectancy, average years of schooling, the share of tertiary students in science, math and engineering, and the share of students enrolled in S&T disciplines.

[8] In the firm survey, the chemical sector includes manufactures of basic industrial chemicals, fertilizers and pesticides, synthetics, resin and related materials, paints, varnishes and lacquers. In addition, petrochemicals, pharmaceuticals, drugs and medicines, soap and cleaning preparations, chemical products, petroleum refineries, miscellaneous petroleum and coal products, tyre and tube industries, rubber products and plastics products are also included in this sector. The metal sector includes basic metal products, fabricated metal products, machinery and equipment; and manufacture of electrical machinery and apparatus.

of these sectors together was around 85.3% of total gross output, 87.6% of total gross value added, 66.8% of capital investment, 76.12% of total labour force, 77.78% of total imports and 84.5% of total number of industrial establishments in the manufacturing sector. In particular, the shares of the food sector accounted for 55.3%, 64.6%, 46.5%, 56.32%, 47.44% and 70.4% respectively, the shares of the textile sector accounted for 2.8%, 2.6%, 0.8%, 5.31%, 0.03% and 0.2% respectively, the shares of the chemical sector accounted for 22.6%, 16.9%, 9.5%, 6.95%, 15.07% and 1.5% respectively, while that for the metal sector accounted for 4.6%, 3.5%, 10%, 7.54%, 14.97% and 12.4% respectively.[9] In addition, 90.23% of total exports of the total manufacturing industries is concentrated in food (46.21%) and chemical (44.02%) industries. The contribution and distribution of these sectors in terms of size of capital and employment implies and enables us to compare between the chemical and metal as capital-intensive sectors and the food and textile sectors as labour-intensive sectors. Table 1 below illustrates the major economic indicators defined according to industrial activities for food, textile, chemical and metal manufacturing industries in the Sudan in 2001.

Table 1 Economic indicators defined by activity for food, textile, chemical and metal manufacturing industries in Sudan (2001)

	Gross Output		Gross Value Added		Gross Fixed Capital Formation		No. of Labour		Export		Import		No. of Establishments	
	Number	%	Number	%	Number	%	Number	%	% of manufacturing in total export	% of sub sector in manufacturing sector	% of manufacturing in total import	% of sub sector in manufacturing sector	Number	%
Food products and beverages	423637059	55.3	216782220	64.6	15459151	46.5	74058	56.32	5.92	46.21	10.05	47.44	16974	70.4
Textiles	21696554	2.8	8728836	2.6	260361	0.8	6982	5.31			0.06	0.3	58	0.2
Total Chemical	172885839	22.6	56599889	16.9	3172453	9.5	9142	6.95	5.63	44.02	3.2	15.07	343	1.5001
Coke, refined petroleum products and nuclear fuel	128838437	16.8	37248469	11.1	193091	0.6	845	0.64	5.33	41.66	0.3	1.4	3	0.0001
Chemicals and chemical products	32851260	4.3	13662594	4.1	2409374	7.2	5636	4.29	0.3	2.36	2.12	10.01	278	1.2
Rubber and plastics products	11196142	1.5	5688826	1.7	569988	1.7	2661	2.02			0.78	3.66	62	0.3
Total Metal	35556940	4.6	11911166	3.5	3330350	10	9909	7.54			3.18	14.97	2978	12.4005
Basic metals	11822060	1.5	1363748	0.4	1511996	4.5	973	0.74			1.91	8.99	139	0.6
fabricated metal products, exc. Mach. and equip.	14482531	1.9	6350759	1.9	722067	2.2	7530	5.73			0.71	3.33	2812	11.7
Machinery and equipment n.e.c	6354330	0.8	3396428	1	230504	0.7	461	0.35			0.26	1.25	15	0.1
Electrical machinery and apparatus n.e.c	2898019	0.4	800231	0.2	865783	2.6	945	0.72			0.3	1.4	12	0.0005
Total sample	653776392	85.3	294022111	87.6	22222315	66.8	100091	76.12	11.55	90.23	16.49	77.78	20353	84.5006
Total Manufactturing	765429858	100	335410844	100	33235336	100	131506	100	12.8	100	21.19	100	24114	100

Source: Adapted from Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001)

In addition, other important reason for the selection of these industries is that the lack of diversification in manufacturing industries implies the high concentration of manufacturing industries on food and oil industries that are the two most important sectors with large shares in manufacturing industries in Sudan. The first evidence for this concentration is the high per capita value added for food and oil industries in the manufacturing sector estimated at US$26.3 and US$4.5 respectively compared to total per capita value added in total manufacturing sector in Sudan estimated at US$ 40.6. In addition the second evidence for this

[9] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

concentration is the high share in value added for food, oil and chemical industries (including oil industries) that accounted for 6.1%, 1.1% and 1.645% respectively, compared to the share of all other sectors together that accounted for only 2.3% of total value added of total manufacturing sector in GDP in Sudan estimated at 9.5%. This implies that 76% of total value added in the manufacturing sector in Sudan is concentrated in food and oil industries that show the high share in value added in the manufacturing sector estimated at about 65% and 11% respectively, they were followed by the chemical and textile sectors that accounted for 4.1% and 2.6% respectively. Moreover, the third evidence for this concentration is the high share in total manufacturing sector exports, for example, 87% of total manufacturing sector exports is concentrated in food (mainly sugar) and oil industries that show the high share estimated at 46% and 41% of total manufacturing sector exports in Sudan respectively. Though this implies the weak structure of industrial exports that still depend basically on exports of raw materials products rather than depend on high valued manufactured products. In addition, the fourth evidence for this concentration is the high share in total imports, for example, 57.41% of the total manufacturing sector imports is concentrated in food and chemical industries that show the high share estimated at 47.4% and 10.01% of total manufacturing sector imports in Sudan respectively. In addition, the fifth evidence for this concentration is the high share in gross output in the industrial manufacturing, for example, 72% of gross output in the manufacturing sector is concentrated in food and oil industries that show the high share estimated at 55% and 17% of total gross output in the manufacturing sector in Sudan respectively. The sixth evidence for this concentration is that food and oil industries constitute 69% of gross output for large industrial establishments and account for the high share of 48% and 21% of gross output for large industrial establishments in Sudan respectively. Finally, further evidence appears from the concentration on food and fabricated metal industries that account for 82% and 62% of total number of manufacturing industrial establishments and total employment in manufacturing industrial sector in Sudan respectively.

Other important reasons for the selection of the chemical industry are the strategic importance of this industry in the international market, and the large important and diversified nature of the chemical sector in the Sudan, as it includes several important products such as basic chemical, batteries, gases, matches, medical and pharmaceuticals, paints, plastics, soap and tyres, ..etc.. Therefore, the chemical sector has the potential to satisfy the diversified needs of the local population, for instance, the soap industries sub- sector is characterized by relatively high range of manufacturing capacities which can supply all the demand for the country and also produce a surplus for export. Moreover, the chemical sector is characterized by capital intensity, for instance, in 2001 the refined petroleum products shows similar/equal intensity of both labour and capital, whereas, the all chemical sector including the refined petroleum products, petrochemical, chemical and plastic sector shows high intensity of capital

and low intensity of labour. It is worthy to note that the contribution of oil industries in total employment represents only 0.5% but in the meantime it is ranked second in terms of the contribution to industrial value added as it accounts for 11% of total industrial value added in the manufacturing industries in Sudan, this implies that oil and chemical industries tend to use more capital intensive techniques and to be a more capital intensive industry. Further strategic importance of the oil and chemical industry is the significant contribution of oil in the promotion of oil related industries and the contribution in the industrial exports and total exports in Sudan. For instance, in 2001, the overall chemical sector including the refined petroleum products, petrochemical, chemical and plastic sector contributes by 44.02% of total manufacturing industrial exports, with the inclusion of the manufacture of refined petroleum products to the all chemical sector, the balance of trade for the all chemical sector tend to show a surplus, whereas the opposite is true with the exclusion of the manufacture of refined petroleum products, the balance of trade for the chemical sector including only the petrochemical, chemical and plastic sector tend to show a large deficit.[10] Moreover, another reason for the selection of this industry is that oil industry has the highest average labour productivity in the industrial sector which is 1,353 times above the average for all manufacturing industrial establishments in Sudan; this also implies high level of technology used in the oil sector.[11] In addition, another reason for the selection of this industry is the high rate of return on investment in capital, for instance, the chemical sector is ranked ninth among the high tenth manufacturing industries in terms of the rates of return on investment in capital accounted for 41% above the average for all manufacturing industries in Sudan 34%.[12]

Other main reason for the selection of food industry is that the food industry sub–sector is a principal sector in the Sudan considering its necessity and it's linkages with the agricultural sector which represents the backbone of the Sudan economy. Moreover, the food industry is diversified by nature and has relatively high range of manufacturing capacities that can satisfy all the demand for the local market in Sudan and also produce a surplus for export, for instance, the food industry sub- sector is characterized by relatively high installed and diversified capacity that can deal with seeds, sunflowers, sesame, peanuts, groundnuts, etc.. Though this also implies the weak structure of manufacturing industrial sector because it is mainly based on agricultural production in Sudan. In addition, another reason for the selection of the food industry is the high rate of return on investment in capital, for instance, the food industry sector is ranked fifth among the high tenth manufacturing industries in terms of the rates of return on investment in capital which accounted for 49% above the average for all manufacturing industries in Sudan(34%).[13] Moreover, another reason for the selection of food

[10] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).
[11] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).
[12] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).
[13] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

industry is the large share in terms of total number of industrial manufacturing establishments and total employment for instance, the sectoral distribution by the number of establishments and employment shows that the food industry is ranked first with high share and accounted for 70% of total number of industrial manufacturing establishments and accounted for more than half (57%) of total employment in manufacturing industrial establishments in Sudan. Furthermore, another reason for the selection of food industry is that the food industry has the large share in the total manufacturing industrial output, for example, total output in food industries represents half of the total output of all manufacturing industrial establishments in 16 states in Sudan. In addition to the large share of food industry in total gross output of small industrial establishments in Sudan, for instance, food industry is ranked first accounted for 88% of total gross output for small industrial establishments in Sudan. Therefore, this implies that since the food industry has the large share in total number of industrial manufacturing establishments, as a result it also has the large share in total output and employment. This also implies that the food industry has the potential to contribute to reduction of the serious unemployment and poverty problems in Sudan as we explained in Nour (2011).

Other reason for the selection of the food industry (sugar sub sector) is the significant contribution of sugar as sub sector in food industry. For instance, in 2001, sugar sub-sector accounted for 33.7%, 26.4% and 5% of total value added, total output and total number of industrial establishments in the food industry respectively.[14] Notably, the selection of food industries is based on the important contribution of sugar industry in terms of total manufacturing employment, as sugar industry alone accounts for 19.4% and 28% of total employment in total manufacturing industrial establishments and total employment in large manufacturing industrial establishments in Sudan respectively. In particular, sugar industry is a significant industry in Sudan, as it employees 25460 labour, all the five sugar factories operating in sugar industry are large size in terms of employment as they all employee more than 100 persons, they tend to be more labour intensive and seem to be more dependent on using labour intensive techniques. Therefore, this implies that the sugar industry has the potential to contribute to reduction of the serious unemployment and poverty problems in Sudan as we explained in Nour (2011). Further to the important share of sugar industry in total manufacturing exports, for example, the sugar industry alone contributes by 46% of total exports of all manufacturing industrial establishments in Sudan. Moreover, due to availability of natural resources and competent professional experts, Sudan has great potentials in terms of Sugar production and now it is ranked second in the African continent following South Africa.[15] Notably, today, the Kenana Sugar Company (KSC) is the world's largest producer of white sugar. Prior to the establishment of the KSC and factory, Sudan imported the bulk of its

[14] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).
[15] See for instance, the Kenana Sugar Company (KSC) web site: www.kenana.com: accessed on November 30, 2010.

sugar, which was a drain on its limited foreign exchange.[16] Furthermore, sugar industry could have a wider utility in the region, given the potential increase in the demand for sugar products due to the possible wider use of sugar, owing to the natural characteristics and environmental consideration of high potential uses of sugar cane in the production of ethanol product as a clean and sustainable environmentally friendly energy source in industry to replace/substitute other non renewable energy sources (such as petroleum). Apart from being a pioneer in agricultural industry, mainly, sugar production, a new generation of environmentally friendly Kenana products are being developed from timber planted within Kenana, while Kenana charcoal has been uniquely created from a by-product of sugar production, bagasse, Kenana animal feed, with its high nutritional value, has also enjoyed substantial export markets in the Gulf. In June 2009, the inauguration of Kenana Ethanol plant factory, marks a historical date for Sudan's entering to the age of green fuel production as of 65 million liters then it reaches up to 200 million liters during the coming two years being it the first of its kind in Africa, thus putting Sudan at an advanced level worldwide in this kind of strategic industries, namely the realm of green fuel. While the world is seeking producing other alternative sources for energy that are environmental friendly and that reduce green house hazards, reduce global warming risks and so contribute to natural solutions to the present world energy and food crisis. Kenana Sugar Company new ethanol fuel plant factory will open the door for biofuel and will also be a new addition to non-petroleum exports. According to economic reports, Sudan could probably be one of the top producing countries for ethanol gas due to its great potentialities and capabilities in green ethanol industry field. The inauguration of the ethanol factory in Kenana is regarded as a significant development in sugar industry and a promotional addition to development process in Sudan. With the opening of ethanol plant, many strategic goals have been achieved by making maximum use of sugar wastes (molasses), supporting Sudan economy by producing other energy sources that reduce the Carbon Dioxide emissions' hazard, improving environment; beside contribution to securing fuel from various sources, particularly with the expectation of several world experts that ethanol would replace the normal fuel within the coming five years when it becomes the major energy element in several countries where traditional energy reservoir is nil. It should be mentioned that ethanol fuel has the advantage that it can be used as a fuel, mainly as a biofuel alternative to gasoline, it is widely used by flex-fuel light vehicles and as an oxygenate to gasoline, because it is easy to manufacture and process and it can be made from very common crops such as sugar cane and corn, moreover, bioethanol, unlike petroleum, is a renewable resource that can be produced from agricultural feedstocks.[17]

[16] See for instance, the Kenana Sugar Company (KSC) web site: www.kenana.com: accessed on November 30, 2010.
[17] See for instance, Sudan Views: sudanviews.net, accessed on November 30, 2010.

Other main reason for the selection of the metal industry is the large share of metal industry in total number of total industrial manufacturing establishments and total gross output of small industrial establishments in Sudan, for instance, fabricated metal industry sub sector is ranked second accounted for near to 12% and 5% of total number of total industrial manufacturing establishments and total gross output of small manufacturing industrial establishments in Sudan respectively. In addition, other important reason for the selection of metal industries is the large share in terms of employment, for instance, fabricated metal industry shows high share and ranked third accounted for near to 7% of total employment in manufacturing industrial establishments in Sudan. Moreover, another reason for the selection of metal industry is the high rate of return on investment in capital, for instance, machinery and equipment and fabricated metal sub sectors are ranked first and sixth among the high tenth manufacturing industries in terms of the rates of return on investment in capital that estimated at 196% and 45% respectively above the average for all manufacturing industries in Sudan (34%).[18] In addition, machinery and equipment is ranked third in terms of average productivity of labour above the average of total industrial manufacturing sector in Sudan.

Other main reason for the selection of the textile industry is the importance of the textile industry in terms of total capacity considering the availability of raw material (cotton) that since long has supported the emergence of textile industry in Sudan. Moreover, the textile industry is among the industries that show high performance in terms of average product which is ten times the average product in all manufacturing industries in Sudan. In addition, other important reason for the selection of the textile industry is the large share in terms of employment in the manufacturing sector in Sudan, for instance, the textile industry shows high share and ranked fourth accounted for near to 6% of total employment in the manufacturing industrial establishments in Sudan. The textile industry contributes highly to employment as it has the tendency to use labour intensive techniques as the majority of the textile firms are among the large size firms in terms of employment and number of labour. Therefore, this implies that the textile industry has the potential to contribute to reduction of the serious unemployment and poverty problems in Sudan as we explained in Nour (2011).

Our results from the firm survey (2010) support the argument presented above concerning the potential contribution of the industry for economic growth and development in Sudan. We find that from the perspective of the industrial firms the respondents firms seem to be highly optimistic regarding the potential contribution of the industrial firms in achieving not only the traditional microeconomic aim of maximising private industrial profit but also in achieving the macroeconomic development aims, provided that the appropriate conditions for industrial development is created. For instance, the potential contribution of the industrial sector in increasing output and income, increasing employment opportunities for present and

[18] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

future labour force (in response to potential population increase), satisfying domestic consumption and achieving self sufficiency by offering the basic and necessary goods for Sudanese, achieving industrial profit, improving production relationships between workers, enhancing local technological capability building by adaptation of imported technologies to fit with local needs. In addition to contribution to economic growth through enhancing industrial linkages, reforming the structural imbalances in Sudan economy, decreasing imports, enhancing optimal and full utilisation of natural resources and local raw materials, enhancing local capability, enhancing development of local technologies to fit with local development needs. In addition to supporting development and urbanisation of all regions in Sudan and enhancing local industrialisation of local raw materials that was earlier exported in the form of raw materials, enhancing economic growth by increasing industrial exports. Finally, meeting the need and enhancing linkage with other sectors especially, agriculture are also mentioned but of somewhat less importance- see Table 2 below.[19]

Table 2– The importance of the industrial sector for economic development in Sudan (2008)

Economic development aims	All	Industry				Size		
	firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Increasing output and income	97%	97%	96%	100%	100%	100%	96%	100%
Increasing employment opportunities for present and future labour force (in response to potential population increase)	91%	89%	93%	90%	100%	88%	92%	100%
Satisfying domestic consumption and achievement of self sufficiency by offering basic and necessary goods for Sudanese	84%	92%	82%	60%	80%	84%	85%	84%
Achieving industrial profit	81%	75%	86%	100%	60%	81%	85%	74%
Creation of improved production relationships between workers	81%	86%	75%	80%	80%	81%	85%	84%
Enhancing local technological capability building by adaptation of imported technologies to fit local needs	73%	78%	64%	70%	100%	91%	65%	63%
Enhancing economic growth by enhancing industrial linkages	67%	61%	71%	70%	80%	69%	58%	84%
Contribution to reform structural imbalances in Sudan economy	67%	69%	68%	50%	80%	72%	62%	74%
Contribution to economic growth by decreasing imports	67%	72%	54%	80%	80%	59%	77%	63%
Supporting the optimal and full utilisation of natural resources and local raw materials	66%	69%	68%	40%	80%	69%	65%	63%
Enhancing local capability	63%	72%	50%	50%	100%	78%	54%	58%
Enhancing local technological capability building and reducing technological dependence by ddevelopment of local technologies	61%	61%	57%	80%	40%	72%	46%	68%
Supporting development and urbanisation of all regions in Sudan	57%	64%	54%	60%	20%	66%	54%	53%
Enhancing economic growth by local industrialisation of local raw materials that was earlier exported in the form of raw materials	49%	44%	54%	30%	100%	63%	46%	32%
Enhancing economic growth by increasing industrial exports	49%	56%	46%	40%	40%	53%	42%	47%
Enhancing economic growth by meeting the need and enhancing linkage with other sectors especially agriculture	42%	44%	46%	30%	20%	53%	35%	37%
Number of respondents	79	36	28	10	5	32	26	19

Source: Own calculation based on the firm survey (2010).

[19] As indicated by 97%, 91%, 84%, 81%, 81%, 73%, 67%, 67%, 67%, 66%, 63%, 61%, 57%, 49%, 49% and 42% of all the respondents firms respectively.

3. Data, definition of variables and general characteristics of firms

Before commencing with the empirical analysis, it is useful to briefly explain the sample and composition of the survey, the data used in our analysis and general characteristics of firms.

3. 1 The selection of the sample and composition of the survey

The empirical investigation in this paper uses a new primary data at the micro level. We collected our primary data using firm survey and interviews that was held in the period from January to June, 2010 in Sudan as a case study of the Arab countries. The selection and focus of our analysis on the Sudan was related to the easy accessibility to data and information and facilities for the fulfillment of the fieldwork/surveys, which were offered by the Department of Economics, Faculty of Economic and Social Studies at the University of Khartoum. As for the motivation, the basic objective of conducting the firm survey was to obtain specific information to provide insights into the factors influencing or the causes and consequences of low skill and technology indicators and to help generate policies to enhance skill and technology. The firm survey discusses the implications of the low technology indicators, low skill level and the excessive use of unskilled workers. The firm survey requested quantitative data to assess industrial performance indicators, technology indicators measured by R&D, patent and ICT and to evaluate skill indicators measured by educational attainment, average years of schooling and experience and occupational level. In addition, additional information was sought to examine the important factors hindering, and those contributing toward enhancing the contribution of the industry across firms.[20, 21] The data from the firm survey provides us with the required information, which is particularly useful for presenting micro analysis to identify the assessment of the industrial performance and the relationships between skill, technology and input-output indicators and consequences of the skills problem from the

[20] The data from the survey is supported by ten face-to-face interviews with firm managers, the purpose of these interviews was to obtain more information to support the findings from the micro survey concerning the low skill level and poor training system, and the implications on low and declining labour productivity and industrial performance, skills mismatch, R&D efforts and development of local technologies, as well as the important factors hindering, and those contributing toward enhancing the contribution of industry in economic development in Sudan.

[21] As for the general structure and design of the questionnaire of the firm survey, the questionnaire in the firm survey was composed of six sections; the average response rate was higher for the sixth section, moderate for the third, fourth and second sections and low for the first and fifth sections. Each of the six sections in the firm survey aimed to request particular information. Section 1 requested general background information about the structure, identification and characteristics of the firms, it also requested (interval) economic quantitative data on the value and trend of firm production and performance indicators, including: employment, net worth (capital), profit, sale, output and product diversification by sale and employment. Section 2 examined the use of technology, level, transfer and dependence on foreign technologies. It assessed technology indicators, patent applications, spending on R&D, and product and process innovations, the use of ICT, firm production and demand for high skilled and also requested quantitative data on the value and trend of ICT expenditure. Section 3 requested quantitative data to measure human capital/skill indicators, defined by the distribution of workers by skill level, educational attainment (average year of schooling), occupational levels, average years of experience, attained and required education and average wages. This section also examined the effect of skilled workers on firm production, the incidence of external effects of schooling, the factors hindering and others contributing toward enhancing the transfer of knowledge at the firm level, firm upskilling plans and their various effects. Section 4 inquired into the implication of technology use on both upgrading skill levels and on the past and future demand for skilled and unskilled workers, and also examined the effect of firm upskilling plans on technological upgrading and self-reliance on local skill. Section 5 investigated the relative importance of the effort of training, the short and long run skill development mechanisms, the coverage, resources and support offered to firm training, the factors hindering and other contribute toward promoting the success of training at the firm level. Finally, section 6 explains the importance of industry and examines the important factors hindering, and those contributing toward enhancing the contribution of industry and it equested recommendations for skill upgrading and technological upgrading in the industrial firms in Sudan.

micro perspectives. The results of the firm survey are quite representative, since the selection and coverage of firms in the survey include a broad range of firms working in the food, textile, chemical and metal industries, which provides us with relevant data and information that of considerable use in our analysis. Such coverage also has the advantage of enabling us to compare between firms according to two criteria, i.e. the size of employment and industrial activity.[22]

The sample in the firm survey was drawn from the small, medium and large size firms working in four industries in the manufacturing sector: the food, textile, chemical and metal industries, which are located in Khartoum State.[23] We observe the imbalanced geographical distribution of manufacturing industrial establishments in Sudan. For instance, the majority of the total, large and small manufacturing industrial establishments are concentrated only in three states, notably, Khartoum (19%, 64%, 15.6%), South Darfur (17%, 5.6%, 17.7%) and Al-Jezira (13%, 7.7%, 13.8%) together they constitute the majority of the total, large and small manufacturing industrial establishments in Sudan (49%, 77.3% and 47.1%) respectively.[24] Therefore, the selection of Khartoum state was based on its significant and highest average share in total number of manufacturing industrial establishments, as Khartoum state represents (18.94%), (64.21%) and (15.61%) of the total number of total, large and small factories and manufacturing industrial establishments respectively in the food, textile, chemical and fabricated metal industries in the Sudan. Moreover, this implies that most probably Khartoum state also has significant large average share in terms of total employment and capital investment. In addition, Khartoum state represents (13.79%), (65.52%) (47.52%), and (26.26%) of the total, large and small factories and industrial establishments in the food, textile, chemical and metal industries in Sudan respectively- cf. Table 3 below.[25] Moreover, the

[22] The firm survey presents some background information, which is also quite useful for a further analysis of firms based on other characteristics such as the geographical location, sector (public-private, mixed), net worth (capital), ownership and nationality of owner (government, foreign, mixed) and foreign orientation or affiliation to multinational corporation (MNC/TNC). Another advantage of the firm survey is that it presents more specific but also quite comprehensive data and information that allow us to use a wide range of quantitative data and information for measuring skill and technology indicators and the link between them at the micro level/ across firms. In addition, the survey data allows us to approximate, examine and to compare between attained and required education and to measure the skills mismatch across firms. At the micro level, realizing the differences in both skill and technologies used across food, textile, chemical and metal industries when comparing their effects and interaction, we define skill by the share of high skilled workers in total employment and technology by the share or total spending on ICT. One major limitation with respect to firm survey is the low response rate for some questions, especially where the answers or data required quantitative measurement. Such problems arose because some of the respondents firms were unwilling to provide complete and reliable quantitative data or some of the respondents firms offered somewhat selective answers. For example, some firms seemed hesitant to provide information about quantitative data on firm industrial performance indicators and also qualitative assessment of input-output indicators ICT and training. The hesitance of some firms compelled us to exclude them when their observations were incomplete, missing and unreliable. Therefore, we used only completed and reliable observations in our estimation and analysis in the next Sections. Apart from this limitation, the data from the firm survey remains useful from both the analytical and policy perspectives and is suitable to use in the empirical investigation in the next sections.

[23] For the purpose of this study, firm size is defined by employment size N. The small size firms are firms with $N < 50$, the medium size firms those with $49 < N < 100$, and the large size firms those with $N \geq 100$ workers.

[24] See for instance, the Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001).

[25] Khartoum state also has strategic importance in Sudan, for instance, Khartoum state accounts for more than half of the country's total revenue, "Khartoum accounted for almost 40 percent of total revenue collection by states in 1996, its share increased to 50 percent in 1999, and is estimated to have increased further [to 71.3 percent] by 2001" (see Brixiova et. al, 2003, p. 5). In addition, in recent years Khartoum has a thriving economy and has seen significant development driven by Sudan's oil wealth and the concentration of investment in the oil, one of Sudan's largest refineries is located in northern Khartoum, petroleum products are now produced in the north of Khartoum state, providing fuel and jobs for the city. Moreover, Khartoum is a tripartite metropolis with an estimated overall population of over five million people, it accounted for 13.5% of total population in 2008

manufacturing industries in Khartoum state is characterized by being more diversified as compared to other states in Sudan. Moreover, the selection of small, medium and large size firms was based on their shares in total employment, they accounted for 18.94% of small and large size enterprises working in the manufacturing sector in Khartoum state (14.54% of small size and 4.4% of large scale enterprises). Our sample drawn from Khartoum state is quite representative, since the coverage of firms in the sample and survey represents 1%, 16%, 28%, and 2% of the food, textile, chemical and metal industries respectively and 2%, 7%, and 1% of the total firms, medium and large size firms and small size firms respectively.[26, 27] We employed the most recent secondary data published by the Sudan Ministry of industry "The Comprehensive Industrial Survey (2005)" in selecting a sample of the firms in the survey.[28]

The questionnaire on "Technological Change and Skill Development" was circulated amongst 100 of the food, textile, chemical and metal small, medium and large size enterprises in the Sudan. It aimed at collecting micro qualitative and quantitative data, and covered the small, medium and large size firms engaged in the food, textile, chemical and metal industries in the Sudan. Table 4 below presents the composition of the firm survey. For the total sample, the total response rate was 87%, and the weighted response rates by employment size were 84%, 88% and 83% for small, medium and large size firms respectively . The response rate varied according to firm size and industrial activity.[29, 30]

(Sudan Central Bureau of Statistics Population Census Data (2009, 2010): 5th Sudan Population and Housing Census 2008). Moreover, it represents a trade and communication center with the highest concentration of economic activity and urban-based services sector in Sudan, such as the construction, telecommunication, iinfrastructure, banking, health and educational services, for instance, Khartoum is the main location for most of Sudan's top educational bodies, it accounted for 31% of total enrolment in higher education in Sudan in 2007 (adapted from the Admission Office cited in Sudan Ministry of Finance and National Economy Annual Report 2007, Table 20-2, p. 24) and it accounted for close to 41.23% of total branches and banking services in Sudan (adapted from the website of the Central Bank of Sudan, accessed on December 01, 2010).

[26] The distribution of firms in the sample is based on two facts: the great diversity of food and chemical compared to metal and textile industries and the potential for upgrading skill and technologies in the large compared to small and medium size firms.

[27] The distribution and representation of firms in the sample is reasonable and representative in view of the fact that majority of manufacturing industrial establishments which were included in the comprehensive industrial survey (2005) that was conducted in 2001 seem to be not working when we conducted the firm survey in Khartoum state over the period January-June 2010.

[28] The Comprehensive Industrial Survey was conducted in 2001 by Sudan Ministry of Industry, Sudan Central Bureau of Statistics, State Governments, Chambers of Industries and technical support from UNIDO. The Ministry of industry executed and published the results of the industrial survey in 2005. The report cover sizes of establishments, ownership, sectoral, composition, geographical distribution, employment, wages and salaries, gross output, manufacturing value added, material intensity and import structure of production, export structure and contribution of sectors to the manufacturing trade balance and factor productivity. The industrial survey covered 2868 manufacturing establishments and the results showed that there are 24.762 of industrial establishments in Sudan, 644 (24%) of them are not working. The survey also showed that 96% of these establishments belong to the private sector and there are no foreign ones among the minor establishments whereas there are 25(1.5%) of foreign establishments among the big establishments and 2.5% foreign and Sudanese ones. The survey results also showed that the State participated in 113(0.5%) of minor industrial establishments and 6.8% in junior establishments and there are 89 of the State public ownership. The minor establishments contributed with a proportion of 40% in the transforming industries. The results imply that 80% of users are concentrated in four industries: foods and drinks 57%, mining products industries 13%, minerals forming 7% and textiles 6%. Total of transforming industries product is 7.654.98 million. Minor establishments contribution is 18% and the junior ones contribution is 82%, the total of the added value is 3.354.308 million- see www.industry.gov.sd

[29] The response rate varied according to firm size and industrial activity: for the food industry the total response rate was 88%, and the weighted response rates by employment size were 83%, 92% and 88% for small, medium and large size firms respectively. For the textile industry the total response rate was 83%, and the weighted response rates by employment size were 100%, 100% and 67% for small, medium and large size firms respectively. For the chemical industry the total response rate was 89%, and the weighted response rates by employment size were 85%, 86% and 83% for small, medium and large size firms respectively. For the metal industry the total response rate was 80%, and the weighted response rates by employment size were 80%, 80% and 80% for small, medium and large size firms respectively.

[30] The share of capital in the sample in Table 4 refers to all respondent firms that respond to the survey question on capital. The high shares of food and small size firms in total capital in the sample imply the high response rates of food and small size firms to the survey question on capital, while the low shares of chemical, metal, textile and medium and large size firms in total capital in the sample imply low response rates of chemical, metal, textile and medium and large size firms to survey question on capital.

Table 3– The total and average share of Khartoum state in total number of establishment in small, medium and large size firms in the food, textile, chemical and metal industries defined by industrial activity and employment size (2001)

Description	Total Sudan				Khartoum	
[Value (000)SD]	Gross total manufacturing output	Value added ('000 SD) [(1)]	Employment	No. of establishments	No. of establishments	
Food products and beverages						
Large	303.38335	170,616,394	46,451	521	194	37.60
% of large	71.61	78.7	62.7	3	8.29	11.73
Small	120.2586	46,170,721	27,607	16,453	2,147	13.05
% of small	28.39	21.3	37.3	97	91.71	9.56
Share in total manufacturing (%)	55.34	64.63	56.32	70.39	9.71	51.25
Share in total large manufacturing (%)	39.63	50.86	35.32	68.23	0.81	4.25
Share in total small manufacturing (%)	15.71	13.76	20.99	2.14	8.90	47.00
Total	423.64195	216,787,115	74,058	16,974	2,341	13.79
Textiles						
Large	21.622658	8,712,934	6,935	38	18	47.37
% of large	99.66	99.82	99.3	65.5	47.37	1.09
Small	0.073896	15,902	47	20	20	100
% of small	0.34	0.18	0.7	34.5	52.63	0.09
Share in total manufacturing (%)	2.83	2.6	5.31	0.24	0.16	0.83
Share in total large manufacturing (%)	2.82	2.60	5.27	0.16	0.07	0.39
Share in total small manufacturing (%)	0.01	0.00	0.04	0.08	0.08	0.44
Total	21.696554	8,728,836	6,982	58	38	65.52
Chemical						
Large	172.461001	56,418,832	8,594	147	117	79.59
% of large	99.75	99.5	96.8	76	71.78	7.07
Small	0.434629	190,845	548	196	46	23.47
% of small	0.25	0.5	3.2	24	28.22	0.20
Share in total manufacturing (%)	22.59	16.88	6.95	1.42	0.68	3.57
Share in total large manufacturing (%)	22.53	16.82	6.54	0.61	0.49	2.56
Share in total small manufacturing (%)	0.06	0.06	0.42	0.81	0.19	1.01
Total	172.89563	56,609,677	9142	343	163	47.52
Metal						
Large	28.423257	8,218,761	4,504	102	80	78.43
% of large	79.94	80.9	79.3	37	10.23	4.84
Small	7.133683	3,692,405	5405	2,876	702	24.41
% of small	20.06	19.1	20.7	63	89.77	3.13
Share in total manufacturing (%)	4.64	3.55	7.54	12.35	3.24	17.12
Share in total large manufacturing (%)	3.71	2.45	3.42	0.42	0.33	1.75
Share in total small manufacturing (%)	0.93	1.10	4.11	11.93	2.91	15.37
Total	35.55694	11,911,166	9909	2,978	782	26.26
Total manufacturing						
Large	628.8	280,689,600	90,605	1,654	1,062	4.40
Small	136.7	54,741,145	40,901	22,460	3,506	14.54
Share in total manufacturing (%)	100	100	100	100	100	18.94
Share of large in total manufacturing (%)	82.14	83.68	68.9	6.9	23.25	64.21
Share of small in total manufacturing (%)	17.86	16.32	31.1	93.1	76.75	15.61
Total	765.5	335,430,745	131,506	24,114	4,568	18.94

Source: Adapted from Sudan Ministry of Industry (2005) the Comprehensive Industrial Survey data for (2001)

Table 4- Composition of the firm survey in the Sudan 2010

Activity And size	**Employment size**	**Share of employment in the sample**	**Share of capital in the sample**	**Number of the respondent firms**	**Share of firms In the response rate (%)**	**Number of firms in the sample**	**Share of firms in the sample**	**Response rate (%)**
(1) Size								
All firms	Small	17.10%	99.18%	21	24%	25	25	84%
	Medium	28.04%	0.06%	29	33%	33	33	88%
	Large	54.86%	0.76%	35	40%	42	42	83%
	Unknown			2	2%			2%
Grand total	Grand total	100%	100%	87	100%	100	100	87%
(2) Activity								
Chemical	Small	3.18%	0.0003%	11	13%	13	13	85%
	Medium	5.00%	0.0169%	12	14%	14	14	86%
	Large	43.75%	0.3951%	15	17%	18	18	83%
	Unknown			2	2%			
	Total	51.93%	0.4123%	40	46%	45	45	89%
Food	Small	12.00%	99.1762%	5	6%	6	6	83%
	Medium	2.04%	0.0031%	11	13%	12	12	92%
	Large	7.47%	0.0296%	14	16%	16	16	88%
	Total	21.51%	99.2089%	30	34%	34	34	88%
Metal	Small	1.48%	0.0000%	4	5%	5	5	80%
	Medium	1.87%	0.0004%	4	5%	5	5	80%
	Large	1.11%	0.3354%	4	5%	5	5	80%
	Total	4.46%	0.3359%	12	14%	15	15	80%
Textile	Small	0.44%		1	1%	1	1	100%
	Medium	19.13%	0.0428%	2	2%	2	2	100%
	Large	2.54%	0.0001%	2	2%	3	3	67%
	Total	22.10%	0.0429%	5	6%	6	6	83%
Grand total	Grand total	100%	100%	87	100%	100	100%	87%

3.2 Data and definition of variables[31]

Our analysis in this paper uses the data from the firm survey (2010), which provides us with three sets of micro variables. The first set includes skill variables, while the second and third sets include both technology and input-output and performance related variables respectively. We define skill variables by educational attainment, occupational level (measured by the required qualifications/schooling years) and average years of experience.[32] We use the total spending on machinery and equipment to define "old technology" and also we use the total spending on ICT[33] to define "new technology", the share of spending on ICT training as a percentage of total spending on ICT to define "upskilling", total sales value to define "output", total profit and total value added to define "performance", in addition we use economic, productivity, activity and profitability indicators to define industrial performance indicators, and total employment and net worth to define "labour" and "capital" inputs, respectively.[34]

We use the first set of skill variables in Section 4 to discuss our first hypothesis in Section 1 above regarding the implications of unskilled workers across firms. We use input-output and performance indicators to illustrate the decline in industrial performance and productivity indicators and ratios. Next, in Section 5, we test our second hypothesis in Section 1 above about the relationships between actual and required education and experience and wages. In Section 6, we use the first and second sets of variables including skill, ICT and the share of spending on ICT training to test the second part of our second hypothesis in Section 1 above regarding the relationship between skill, technology (ICT) and upskilling. Next, we use the second and third sets of technology and input-output variables to test the third hypothesis in Section 1 above about the relationship between technology (ICT) and input-output indicators.[35]

3.1.2 General characteristics of firms

Table 5 presents the main general characteristics of firms and economic indicators such as the share of firms in total employment, capital, profit and output (total sales value), and their differences defined by firm size and industry level. We observe that the market size or

[31] All data, information and analysis in this chapter are based on the results covering 45 firms obtained from the firm survey (2010).

[32] We classify the educational qualifications of workers into three groups: high skilled (H) with postgraduate, university and diploma degree (more than twelve years of schooling), medium skilled (M) with secondary education (twelve years of schooling) and low skilled (L) with less than secondary education (less than twelve years of schooling). We define the occupational status according to five categories, including white-collar high (managers, professionals, management executives, scientists, technicians and engineers); white-collar low (clerical and administrative); blue collar high (skilled craftsmen); blue-collar low (plant machinery operators, assemblers and elementary occupation) and other workers. We define the required qualifications by required years of schooling including: postgraduate/ Ph.D. (19-20 years); professional, MSc./ postgraduate (18 years); university graduate (16 years); diploma (14 years); higher secondary schooling (12 years); and less than secondary schooling (less than 12 years). We measure the average wages by average monthly wages (in Pounds, the Sudanese national currency), and average years of experience by both actual and required average years of experience for both educational and occupational definition respectively.

[33] ICT is the sum of total expenses on computers, telecommunications, internet, training, maintenance and other related items.

[34] We measure output by the total sales value because the measurement units of sales value is unified (in local currency) across firms, while the measurement units of output in physical terms (tonne, litre, etc.) varies enormously across firms.

[35] We use few observations in the estimated equations, due to limited availability of reliable data covering these indicators, because some of the respondent firms were particularly reluctant to provide adequate reliable quantitative data covering these indicators.

structure – defined by the share in total employment, raw materials, profit, fixed capital and value added – seems biased toward large size and chemical and food firms respectively. For instance, on average, the large size and chemical firms respectively employ 74% and 50% of total workers, absorb 99% and 73% of total raw materials, and therefore, it is not surprising that they constitute 99% and 72% of total profit. While small size and food industries absorb 99% and 99% of total capital, large size and food industries absorb 84% and 83% of total fixed capital in the form of machinery and equipment and hence, it is not surprising that they constitute 84% and 84% of total values added respectively.[36] In addition, medium size and food industries constitute 63% and 75% of total output (total sales value). These differences in market size leads to several implications, as we explain below and in the next sections.

From Table 5 we observe the limited contribution of public sector and high share of private sector in the metal, food, chemical and textile industries and medium, small and large size firms respectively. We also note the high share of local ownership and also a limited share of foreign and mixed ownership, which implies the limited dependency on foreign capital and foreign workers. We find that the share of firms in local ownership decreases and so the share in foreign ownership increases with firm size and to some extent with industry level. But despite the presence of foreign capital, there is limited contribution of multinational companies; however, such contribution is diversified as the sources of foreign capital of multinational companies originates from different countries and increases to some extent with industry level and to less extent with firm size. We also observe limited changes in the general structure of firms during the period 2005-2008, which may indicate a lack of dynamism, particularly with respect to the distribution of economic indicators, i.e. total employment, capital and output/sales value across firms. The reported change since establishment and in ownership, nationality of main owner and length of years in operation (age) varies across firms and generally increases with firm size and industry level, it was observed not at all time but only are relatively and somewhat only in the chemical industries and large and small size firms. In addition, the geographical distribution of firms indicates that most of firms are clustered in two main locations and only few of the chemical, food and metal industries and large and medium size firms have branches in cities other than the main location, though the probability of clustering not at all time but to some extent increases with firm size and industry, and the probability of having branches increases with firm size but not at all time and to less extent increases with industry. Moreover, we realize the limited scope for

[36] We believe that our results should be interpreted carefully, notably when explaining our results related to the share of firms in total capital which indicate the large share of small size and food industries that absorb 99% and 99% of total capital. In particular, we interpret these results due to the relative availability of information and quantitative data covering these financial indicators, notably, due to relatively more response to provide information and quantitative data covering these financial indicators for small size and food industries as compared to other firms, particularly because some of the firms seem to be more reluctant to provide adequate reliable information and quantitative data covering these financial indicators for medium and large size, chemical, metal and textile firms.

diversification as measured by sales and employment indices across firms.[37] The average diversification index increases to some extent with firm size but only to less extent increases with industry: this implies that metal and chemical industries and large size firms have more interest in diversification, whereas food and textile industries and medium size firms have less interest in diversification and more interest in concentration and specialization. As expected, large size firms reported more interest in diversification than medium and small size firms. Somewhat surprising and in contrast to our expectations, the findings across firms indicate that metal firms reported more interest in diversification more than chemical, food and textile firms, moreover, somewhat surprising small size firms indicated more interest in diversification more than medium size firms.

[37] We use a modified definition of the diversification index developed by Utton (1979). We define the diversification index by output/ sales diversification Di = [P1+2 P2+3P3 + 4P4] -1/ 2], where Pi refers to the percentage share of diversified sale product in total sale products within firms. Ranked from large to small, when Di = 1, Di =4 and 1< Di < 4, it implies complete specialization, complete diversification and some degree of diversification respectively. We apply the same definition for employment diversification index (cf. Utton, 1979: 15-16, 104-105).

Table 5- Main characteristics of firms in the Sudan (2005-2008)

Main indicators (2005- 2008) [1]		No. of respondent firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Share in employment (%)	2005	85	45%	37%	4%	13%	71%	18%	10%
	2006	85	52%	32%	4%	13%	73%	17%	10%
	2007	85	51%	25%	4%	20%	76%	16%	9%
	2008	85	52%	22%	4%	22%	77%	16%	7%
	Average 2005-2008	85	50%	29%	4%	17%	74%	17%	9%
Share in capital (%)	2005	83	0.4%	99.3%	0.2%	0.1%	0.5%	0.5%	99%
	2006	83	0.4%	99.1%	0.4%	0.1%	0.5%	0.5%	99%
	2007	83	0.4%	99.0%	0.5%	0.1%	0.5%	0.5%	99%
	2008	83	0.4%	99.1%	0.3%	0.01%	0.5%	0.5%	99%
	Average 2005-2008	83	0.4%	99.2%	0.3%	0.1%	0.5%	0.5%	99%
Share in machinery and equipment (%)	2005	45	2%	94%	2%	2%	95%	0.5%	4.5%
	2006	45	9%	79%	7%	4%	84%	0.5%	15.5%
	2007	45	12%	79%	9%	0%	78%	1%	20%
	2008	45	11%	80%	8%	0%	80%	1%	19%
	Average 2005-2008	45	9%	83%	7%	2%	84%	1%	15%
Share in raw materials(%)	2005	45	1%	96%	2%	1%	97%	0.5%	2.5%
	2006	45	96%	3%	1%	0%	99%	0.5%	0.5%
	2007	45	95%	4%	0%	0%	99%	0.5%	0.5%
	2008	45	98%	2%	0%	0%	100%	0.5%	0.5%
	Average 2005-2008	45	73%	26%	1%	0%	99%	0.5%	0.5%
Share in profit (%)	2005	45	1%	90%	12%	0%	99%	0.5%	0.5%
	2006	45	95%	5%	0%	0%	99%	0.5%	0.5%
	2007	45	95%	3%	1%	0%	99%	0.5%	0.5%
	2008	45	96%	2%	2%	0%	99%	0.5%	0.5%
	Average 2005-2008	45	72%	25%	4%	0%	99%	0.5%	0.5%
Share in output (total sales value)(%)	2005	45	0%	99%	1%	0%	22%	78%	1%
	2006	45	27%	72%	1%	0%	36%	59%	6%
	2007	45	30%	67%	2%	0%	40%	59%	1%
	2008	45	36%	62%	2%	0%	45%	54%	1%
	Average 2005-2008	45	23%	75%	2%	0%	36%	63%	2%
Share in value added (%)	2005	45	5%	94%	1%	0%	99%	0.5%	0.5%
	2006	45	2%	92%	5%	1%	90%	0.5%	9.5%
	2007	45	5%	77%	17%	1%	76%	4%	20%
	2008	45	8%	74%	18%	1%	71%	6%	22%
	Average 2005-2008	45	5%	84%	10%	1%	84%	3%	13%
Share in wage (%)	2005	45	1%	92%	2%	5%	97%	0.5%	2.5%
	2006	45	4%	66%	12%	18%	86%	0.5%	13.5%
	2007	45	9%	77%	14%	0%	80%	1%	19%
	2008	45	10%	80%	9%	0%	82%	2%	17%
	Average 2005-2008	45	6%	79%	9%	6%	86%	1%	13%
Share in spending on ICT (%)	Average 2005-2008	54	23%	53%	11%	13%	48%	21%	30%
Share in spending on ICT training (%)	Average 2005-2008	8	2%	73%	12%	13%	75%	18%	7%
Share of private firms (%)	2008	87	89%	94%	100%	80%	89%	97%	90%
Share of ownership (%) [2]	Local- 2008	87	86%	92%	68%	88%	80%	84%	95%
	Foreign- 2008	87	15%	8%	32%	12%	20%	16%	5%
Share of main owners(%)	Local – 2008	87	79%	87%	62%	80%	69%	83%	90%
	Foreign - 2008	87	8%	3%	23%	0%	9%	14%	0%
	Mixed – 2008	87	13%	10%	15%	20%	23%	3%	10%
Affiliation to multinational	2008	87	11%	6%	8%	0%	9%	10%	5%
Change after establishment [3]	2008	87	8%	0%	0%	0%	6%	0%	5%
Main location (%)	Khartoum – 2008	87	26%	23%	38%	0%	26%	24%	29%
	Khartoum North-2008	87	58%	68%	46%	80%	57%	62%	71%
	Omdurman - 2008	87	16%	10%	15%	20%	17%	14%	0%
Branches other than main location (%)	2008	87	3%	10%	15%	0%	14%	3%	0%
Average age/ operation years	2008	87	18	17	14	16	19	14	17
Average rate of diversification	Sales – 2008	86	1.50	1.47	1.52	1.23	1.57	1.36	1.54
	Employment - 2008	63	1.40	1.31	1.55	1.17	1.47	1.19	1.44

Notes: (1) All indicators are calculated from the firm survey (2010); some refer to observations over only one year (2008) and others use observations over 4 years (2005-2008). (2) Some of the respondent firms reported a mixed share of local and foreign ownership. (3) Change after establishment refers to changes in ownership, management and structure (e.g. expansion; opening new branches or merger with other firms).
Sources: Firm Survey (2010)

4. *Differences in skill level and requirements and the implications across firms*

Our earlier findings in Nour (2011) indicate that the share of high skilled workers in total employment, the number of full time equivalent researchers, R&D and ICT expenditure, patent, product and process innovations are higher within large size and chemical firms when compared to medium and small size and food, metal and textile firms. Our result with respect to R&D and chemical sector is consistent with the standard classification developed by the OECD in the mid-1980s, which distinguishes between industries in terms of R&D intensity (cf. OECD, 1997). For instance, in the mid-1980s, the OECD classification distinguished between industries in terms of R&D intensity, considering pharmaceutical and ICT as high-technology, chemical and vehicle as medium-technology and food and textile as low technology (cf. OECD, 1997). Our findings with respect to firm size are consistent with the literature and the Schumpeterian hypothesis, which indicate that large size/market concentration is conducive to R&D investment (cf. Braga and Willmore, 1991). For instance, Kumar and Saqib (1994) suggest that the probability of undertaking R&D increases with firm size only up to certain level, while R&D intensity increases with it linearly. However, one should also expect that these results could imply a possibility for reversed causality, mainly because R&D is a fixed cost that requires high financial capacity, which is most likely to be strong amongst large size firms.

In addition to earlier findings, we observe that skill levels and requirements (actual and required education and experience) and skills mismatch are not homogenous across firms and vary with industry and size. As we explained in Section 4, these findings can be used to test the first hypothesis that, irrespective of these differences, high skill requirements and low skill levels – due to high share of unskilled workers – lead to skills mismatch and also contribute to industrial performance indicators and productivity decline across firms. In Sections 5 and 6, we then examined the second hypothesis that an increase in skill levels and firm size lead to improved relationships between actual and required education and experience; between actual education, experience and wages; and between skill, upskilling and technology (ICT). Finally, in Section 6, we also investigated the third hypothesis concerning the relationships between technology (the use of ICT) and input-output indicators at the micro/firm level.

4.1 Differences in skill level and requirements (education and experience) across firms

Prior to investigating the first hypothesis on the extended implications of low skill levels as presented above, it is convenient to begin with explaining differences in skill levels and requirements across firms because understanding why and how they vary with industry and firm size can help in investigating both the first and second hypotheses.

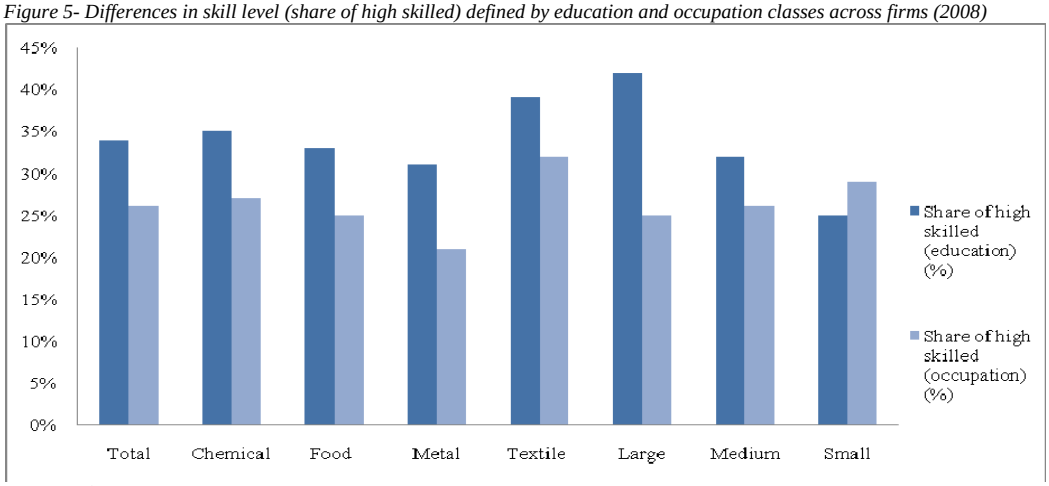
In Figures 6- 8 below we explain differences in skill levels and requirements and low skill levels – defined by education and occupation groups – across firms defined by size and

industry.[38] Figures 6 and 7 show the low share of high skilled – high educated and white-collar – workers, differences in skill levels according to education and occupation definitions and differences across firms. For instance, Figure 6 indicates that for 55% of all respondent firms, the share of high skilled (educated) represents 1-30% of total employed workers. For a further 20% of all respondent firms, the share of high skilled (educated) represents 31-50% of total employed workers, but for the remaining 25% the share is more than 50% of the workforce. Figure 7 shows, for example, that for 66% of all respondent firms, the share of white collar (WC) represents 1-30% of total employed workers; for 21% of all respondent firms the WC share is 31-50% and for 13% the figure stands at 50% of total employed workers. The results show that the incidence of high educated and white-collar workers constituting more than half of total employment is observed only within 25% and 13% of all respondent firms respectively. They also indicate that the share of high skilled – measured by education – is less than one third of total workers for 55% of all firms and the share of high skilled – white-collar measured by occupational level – is less than one third of total workers for 66% of all firms. That means that across all firms the share of high educated and white-collar respectively are less than one third and two thirds; therefore, the majority of employed workers are low and medium skilled. Figures 8 and 9 show that skill requirements – average required years of schooling – vary and increase with occupational level across firms.[39] For instance, Figure 8 indicates that for 26% of all respondent firms the average required years of education for white collar (WC) is 12 and above; 68% of all respondent firms require an average of 16 years; whilst 6% of all respondent firms put this figure at 18 and above. Moreover, Figure 9 indicates that for 16% of all respondent firms the average required years of education for white collar high (WCH) is 14 years (diploma degree); for 47% the requirement is 16 years (university degree); and for 37% the requirement is 17-19 years and above (post graduate degree). The figures show that the university degree is the major preferred required qualification only within the first and second occupational groups, while for the other occupational groups either a diploma or secondary or less than secondary schooling is required.

[38] In Figures 6-8, the horizontal axis defines firms, industry, size (chemical, food, metal and textile, large, medium and small), and skill level (high (H), medium (M) and low (L)). The vertical axis defines the intensity/share of H, M and L across firms. The information in the right margin defines the distribution of workers in Figures 6-7, and the average required years of education in Figure 8.

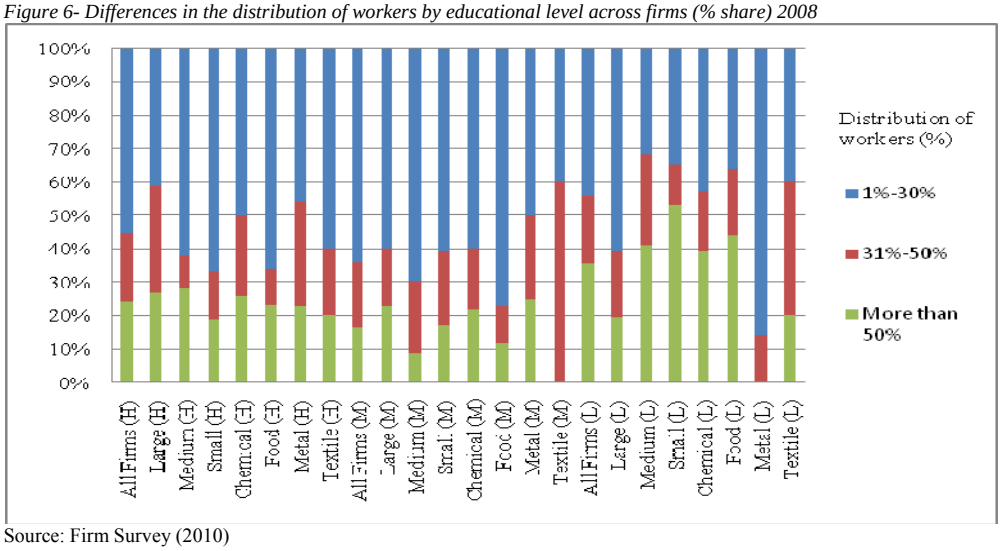
[39] White collar (WC) includes white collar high and low. Blue collar (BC) includes blue collar high and low.

Figure 5- Differences in skill level (share of high skilled) defined by education and occupation classes across firms (2008)



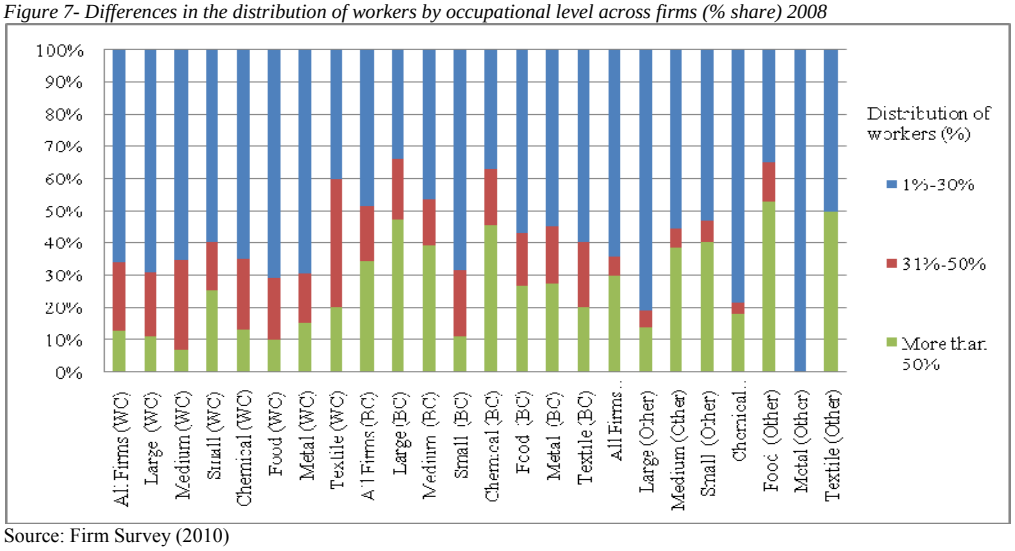
Sources: Firm Survey (2010)

Figure 6- Differences in the distribution of workers by educational level across firms (% share) 2008



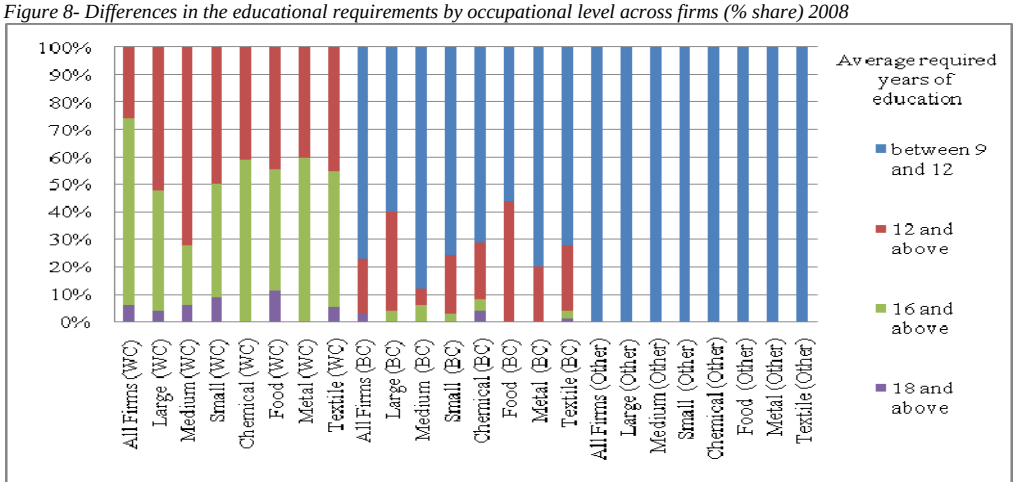
Source: Firm Survey (2010)

Figure 7- Differences in the distribution of workers by occupational level across firms (% share) 2008



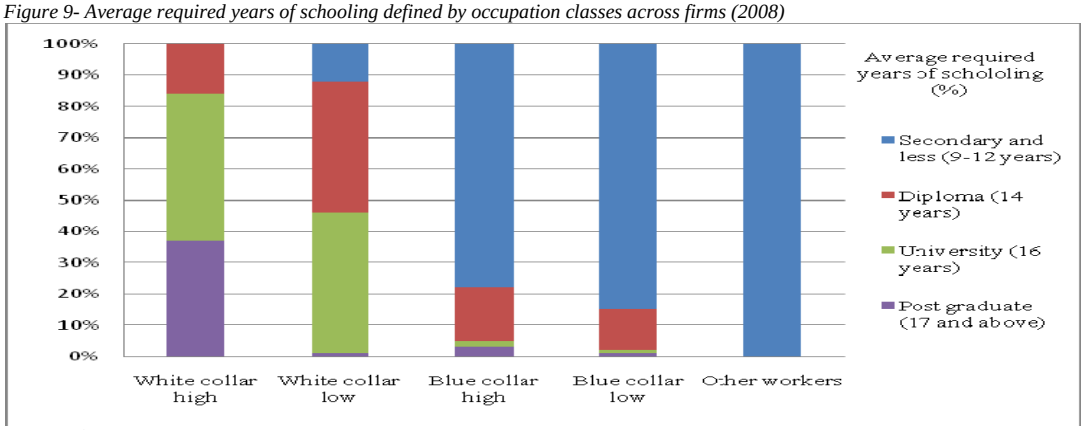
Source: Firm Survey (2010)

Figure 8- Differences in the educational requirements by occupational level across firms (% share) 2008



Source: Firm Survey (2010)

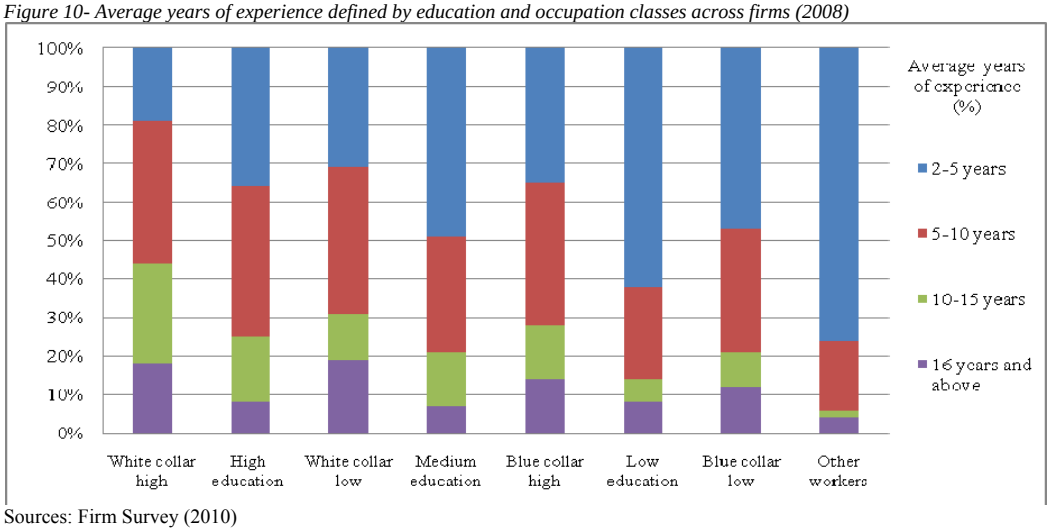
Figure 9- Average required years of schooling defined by occupation classes across firms (2008)



Source: Firm Survey (2010)

Figure 10 below indicates the variation in skill requirements (required years of experience), defined by educational and occupational levels. For instance, for 36% of all respondents firms the average required years of experience for high education is 2-5 years; for 39% the experience requirement stands at 5-10 years, for 17% the experience requirement stands at 10-15 years; and for 8% the figure is 16 years and above. Moreover, for 19% of all respondents firms the average required years of experience for white collar high (WCH) is 2-5 years; for 37% the experience requirement stands at 5-10 years, for 26% the experience requirement stands at 10-15 years; and for 18% the figure is 16 years and above. Figure 10 illustrates that average years of experience are increasing in educational and occupational levels respectively. In the next section, we explain the relationships between required education/ actual education; occupation/required education; and experience and wages across firms.

Figure 10- Average years of experience defined by education and occupation classes across firms (2008)



Sources: Firm Survey (2010)

4.2 The implications of low skill levels across private firms

In this section we examine the first hypothesis that, irrespective of the observed differences in skill levels and requirements and as we explained above, the low skill levels – due to high share of unskilled workers – lead to skills mismatch and probably contribute to industrial performance indicators and productivity decline across firms.

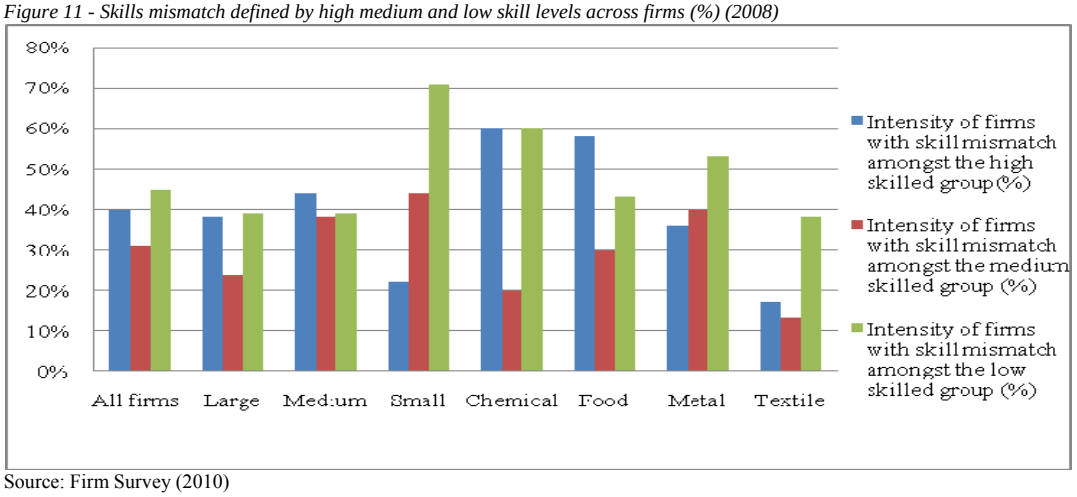
a. Low skill levels and skills mismatch (differences in required and attained education)

When comparing the required schooling with the actual/attained schooling, we find that differences in schooling requirements across firms have caused considerable variations between the required and actual/attained schooling for high, medium and low skilled groups. When we interpret the required schooling as the demand for skills and the actual/ attained schooling as the supply of skills, we observe that the inconsistency between the required and actual/ attained schooling indicates an inconsistency between the demand for and supply of skills, which can be interpreted as skills mismatch.[40] For instance, Figure 11 below illustrates the differences between the required and actual/ attained schooling across firms defined by firm size and industry level and skill levels. We observe that the inconsistency between the demand for and supply of skills, or skills mismatch, is particularly higher/ serious within both

[40] Our definition of actual education refers to educational attainment classified under three groups: high (post secondary) educational attainment: university degree and above (16 years of schooling); medium educational attainment: secondary education (12 years of schooling); and low educational attainment: less than secondary education (9 years of schooling). We define the required education by the translated merged required qualifications for each occupation group defined by average years of schooling. The occupational classification includes the following five categories/ groups: (1) Managers, professional, management executive, scientific, technical and engineers; (2) Clerical and administrative; (3) Skilled craftsmen; (4) Plant machinery operators, assemblers and elementary occupation; and (5) Other workers. We translate the required qualifications associated with each occupational class into average years of schooling and group them in the following way: (1) PhD/postgraduate (19-20 years); (2) Professional, MSc./ postgraduates (18 years); (3) University graduate (16 years); (4) Diploma (14 years); (5) Higher/ Secondary Schooling (12 years) and (6) Less than Secondary Schooling (9 years). We then merge the required qualifications into three groups, assuming that the high occupation group includes both the first and second occupation categories, the medium occupation group includes both the third and fourth occupation categories and, finally, the low occupation group includes the fifth occupation category. We then use this definition to compare between the required education for each occupation class and actual/ attained education, and we assume that the difference between these indicates the presence of skills mismatch between jobs requirements and educational attainment.

high and low skilled groups respectively and across medium, small, chemical, food and metal firms respectively. We find mismatch amongst all employment categories, especially within high, medium and low skilled labour: for instance, we observe that for all firms, on average, the intensity of mismatch for high, medium and low skill groups accounts for 40%, 31% and 45% respectively. This implies that the educational attainment amongst high, medium and low skilled labour does not match the required skills/educational level for high, medium and low skilled jobs across approximately 40%, 31% and 45% of total respondents firms respectively. The mismatch is highest for high, medium and low skills, probably because of both insufficient educational attainment and high educational requirements for high, medium and low skills – see Figure 8 above. Moreover, the intensity of mismatch is more prevalent across small size and medium size and chemical, metal and food firms compared to large size and textile firms. For instance, for medium size firms, on average the mismatch intensity for high, medium and low skill groups accounts for 44%, 38% and 39% respectively, while for small size firms the figures are 22%, 44% and 71% respectively, whereas for large size firms the figures are 38%, 24% and 39% respectively. Moreover, for the chemical industries, on average the mismatch intensity for high, medium and low skill groups accounts for 60%, 20% and 60% respectively, while for food industries the figures are 58%, 30% and 43% respectively, whereas for metal industries the figures are 36%, 40% and 53% respectively, while for textile industries the figures are 17%, 13% and 38% respectively. Hence, our results in this section concerning the presence of serious skills mismatch due to the excessive share of unskilled foreign workers at the micro level are consistent with our earlier findings in Nour (2011), which indicates the presence of serious skills mismatch at the macro level.

Figure 11 - Skills mismatch defined by high medium and low skill levels across firms (%) (2008)



Source: Firm Survey (2010)

b. Low skill levels and the declining trend of labour productivity (output/labour ratio)

The low skill levels may contribute to productivity decline across firms.[41] Table 6 below illustrates considerable variation in the value and trend of labour productivity (total output/labour ratio) in physical term, in particular, considerable decline in labour productivity(output/labour ratio) for numerous firms over the period 2005-2008.[42, 43, 44]

The declining labour productivity across many firms may not be surprising since the majority of employed workers are low skilled/educated workers – see our result above–a low skill level may lead to further decline in productivity. For instance, Table 6 below shows that over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 8 out of 37 (22%) of all respondent firms and the increasing trend continues across 16 out of 37 (43%) firms; however, the increasing trend turns into a declining one across 11 out of 37 (30%) firms, or the declining trend continues across 2 out of 37 (5%) of all respondent firms. Hence, for the majority 24 out of 37 (65%) of all respondent firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 13 out of 37 (35%), i.e. for more than one third of all firms either the increasing trend turns into a declining one or the declining trend continues. For chemical firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 5 out of 18 (28%) of the chemical firms and the increasing trend continues across 9 out of 18 (50%) firms; however, the increasing trend turns into a declining one across 2 out of 18 (11%) firms, or the declining trend continues across 2 out of 18 (11%) of the chemical firms. Thus, for the majority 14 out of 18 (68%) of the chemical firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 4 out of 18 (22%), i.e. for more than one fifth of the chemical firms either the increasing trend turns into a declining one or the declining trend continues. For food firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 1 out of 12 (8%) of the respondent firms and the increasing trend continues across 6 out of 12 (50%) firms; however, the increasing trend turns into a declining one across 5 out of 12 (42%) firms. Therefore, for more than half or the majority 7 out of 12 (58%) of the food firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 5 out of 12 (42%), i.e. for more than one third and near to one

[41] Productivity is measured in physical terms (tonne, litre, etc.) for selected firms according to availability of data.
[42] The results from the firm survey (2010) indicate that the declining labour productivity seem to be more sensitive to industry level and less sensitive to firm size as reported by 35%, 22%, 42%, 67%, 50%, 47%, 20% and 33% of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.
[43] Due to the small number of observations on the declining trend of labour productivity, our results should be interpreted carefully as probably this may not be the only case; other possible explanations are either the steady or increasing trends amongst the non-respondent firms.
[44] In Table 3 we limit our analysis of the productivity decline to compare only the change in labour productivity over the period 2005-2006, 2006-2007 and 2007-2008 across 42 of the respondent firms. Since our data only reflects skill levels for the year 2008, but does not reflect the change in skill levels over the period 2005-2008. That means we cannot compare the change in productivity with the change in skill levels, so as to attribute the declining trend in productivity over the period 2005-2008 to the declining trend in skill levels.

half of the food firms either the increasing trend turns into a declining one or the declining trend continues. For metal firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 1 out of 3 (33%) of the metal firms; however, the increasing trend turns into a declining one across 2 out of 3 (67%) of the metal firms. Hence, for the majority 2 out of 3 (67%), i.e. for more than two third of the metal firms the increasing trend turns into a declining one, but for the remaining 1 out of 3 (33%) the declining trend turns into an increasing one. For textile firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 1 out of 4 (25%) of the textile firms and the increasing trend continues across 1 out of 4 (25%) firms; however, the increasing trend turns into a declining one across 2 out of 4 (50%) firms. Thus, for the half 2 out of 4 (50%), i.e. for one half of the textile firms either the declining trend turns into an increasing one or the increasing trend continues, while for the other half 2 out of 4 (50%) the increasing trend turns into a declining one. For large size firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 4 out of 15 (27%) of the large size firms and the increasing trend continues across 4 out of 15 (27%) firms; however, the increasing trend turns into a declining one across 6 out of 15 (40%) firms, or the declining trend continues across 1 out of 15 (7%) of the large size firms. Thus, for the majority 8 out of 15 (53%), i.e. for more than one half of the large size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 7 out of 15 (47%) either the increasing trend turns into a declining one or the declining trend continues. For medium size firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 3 out of 10 (30%) of the medium size firms and the increasing trend continues across 5 out of 10 (50%) firms; but, the increasing trend turns into a declining one across 2 out of 10 (20%) of the medium size firms. Thus, for the majority 8 out of 10 (80%) of medium size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 2 out of 10 (20%) , i.e. for one fifth of the medium size firms the increasing trend turns into a declining one. For small size firms over the periods 2005-2006, 2006-2007 and 2007-2008, the declining trend of labour productivity is reversed across 1 out of 12 (8%) of the small size firms and the increasing trend continues across 7 out of 12 (58%) firms; however, the increasing trend turns into a declining one across 3 out of 12 (25%) small size firms, or the declining trend continues across 1 out of 12 (8%) of the small size firms. Thus, for the majority 8 out of 12 (67%) of the small size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 4 out of 12 (33%), i.e. for one third of small size firms either the increasing trend turns into a declining one or the declining trend continues.

Table –6- Assessment of industrial performance: llabour productivity: output/labour ratio measured in physical term across firms (2005-2008)

Variables		Value (2005-2008)				Trend (2005-2008)				Growth rate (2005-2008)			
Average ratio of prod/lab	Group of firms	2005	2006	2007	2008	2005-2006	2006-2007	2007-2008	2005-2008	2005-2006	2006-2007	2007-2008	2007-2008
Chemical	Small	104727.27	119172.41	119172.41	199384.62	+		+	+	14		67	90
		40088.065	59703.806	108426.95	123457.95	+	+	+	+	49	82	14	208
		36000000	32000000	16666667	16666667	-	-		-	-11	-48	0	-54
		2222222.2	2666666.7	3125000	3500000	+	+	+	+	20	17	12	58
		66666.667	71428.571	100000	111111.11	+	+	+	+	7	40	11	67
		57500	63333.333	70000	76666.667	+	+	+	+	10	11	10	33
					25452.475			+	+				
	Medium	1	1	1	8			+	+			700	700
		34379.275	45957.464	33308.435	19848.217	+	-	-	-	34	-28	-40	-42
				18700	36083.333		+	+	+				
		3555.5556	3384.6154	6000	6666.6667	-	+	+	+	-5	77	11	87
	Large		57.915058	61.776062	34.749035	+	+	-	+		7	-44	
				31500	69443.925		+	+	+			120	
		2632.9588	2840.8	2535.7143	3392.3077	+	-	+	+	8	-11	34	29
		78750	70000	120000	133333.33	-	+	+	+	-11	71	11	69
		26557.053	23979.592	20715.596	14434.783	-	-	-	-	-10	-14	-30	-46
			42.857143	41.25	41.257778	+	-	+	+		-4		
				156393.16	179986.3		+	+	+			15	
		78026.433	77137.71	85601.63	90375.527	-	+	+	+	-1	11	6	16
Food	Small	6666.6667	18181.818	36000	1500000	+	+	+	+	173	98	4067	22400
					3055555.6			+	+				
			166.66667	233.33333	400	+	+	+	+		40	71	
		13437500	1.875E+09	15625000	15000000	+	-	-	+	13853	-99	-4	12
	Medium			60023.543	63433.078		+	+	+			6	
		68432.523	87238.779		17700.333	+	-	+	-	27	-100		-74
		673043.48	673043.48	673043.48	673043.48								
		17.763158	20	24.193548	29.824561	+	+	+	+	13	21	23	68
			4122.75	6369.5918	14983.607	+	+	+	+		54	135	
		7812.5	8531.25	10000	7995.5156	+	+	-	+	9	17	-20	2
	Large	172413793	155172414	181034483	65517241	-	+	-	-	-10	17	-64	-62
		96	100.46512	105.36585	109.36709	+	+	+	+	5	5	4	14
		84975.92	97098.257	123589.7	78070.618	+	+	-	-	14	27	-37	-8
		1600	1750	1987.1795	1826.9231	+	+	-	+	9	14	-8	14
Metal	Small				600000			+	+				
		29500	43500	54666.667	5909.0909	+	+	-	-	47	26	-89	-80
		67045455	123456790	79069767	283333333	+	-	+	+	84	-36	258	323
	Medium				538461.54			+	+				
	Large	166.66667	200	235.29412	218.18182	+	+	-	+	20	18	-7	31
Textile	Small	937.5	1187.5	1615.3846	1538.4615	+	+	-	+	27	36	-5	64
	Medium	54110.855	75207.851	47192.489	65621.116	+	-	+	+	39	-37	39	21
	Large			45	450.23333		+	+	+			901	
		251845.94	8436724.6	69963.713	64541.195	+	-	-	-	3250	-99	-8	-74

Source: Own calculation based on the firm survey (2010).

Therefore, our results in this section concerning the declining labour productivity are consistent with our results regarding the declining industrial performance indicators that we measure by three sets of economic-productivity, activity and profitability indicators at the micro level as we show in the next section- see Tables 7-8 below.

c. Low skill levels and the declining trend of other industrial performance indicators

The low skill levels may contribute to the decline of industrial performance indicators across firms. The trend of these indicators show large variation across firms, in most cases seem to be more sensitive to differences in firm size, industry and sector, mainly, the performance for different indicators show a great decline for many firms over the period 2005-2008. Tables 7-8 below show the value and trend of industrial performance indicators across firms over the period (2005-2008) that we define by three different sets of economic and productivity indicators, activity indicators and profitability indicators. Using Al-Quraishi (2005) definition of industrial performance, first, we define the first set of economic indicators by three indicators including first the degree of industrialization that we define by the ratio of total value added as a percentage of total output defined by total sales value and second the capital intensity level indicators that we define by the ratios of capital and fixed capital-defined by

total spending in machinery and equipment- as percentages to total labour respectively. We define the third economic indicator by a set of productivity indicators that we define by labour productivity indicator defined by the ratio of total value added as a percentage to total labour; capital productivity indicator measured by the ratio of total output defined by total sales value as percentages of total capital; fixed capital productivity indicator defined by the ratio of output defined by total sales value as a percentage of fixed capital (machinery and equipment); wage productivity indicator that we define by the total output defined by total sales value as a percentage of total wage and raw materials productivity indicator defined by the ratio of total output defined by total sales value as a percentage to total spending on raw materials. Second, we measure the second set of activity indicators by the fixed capital turnover ratio that we define by the ratio of total sales value as a percentage of fixed capital and the capital turnover ratio that we define by the ratio of total sales value as a percentage of total capital. Third, we measure the third set of profitability indicators by three indicators: the rate of return on labour that we define by profit/labour ratio, the rate of return on capital that we define by the ratio of profit as a percentage to capital and profit margin indicator that we define by the ratio of profit as a percentage to total sales value- (see Al-Quraishi, 2005: 249-277).

Beginning with the first set of economic indicators, we find that for all firms the trend of value and growth rate of the economic indicator as measured by the degree of industrialization as measured by the value added/sales value (output) ratio show a negative decreasing trend over the periods (2005-2006) and (2005-2008) but that again turned into a positive increasing trend over the periods (2006-2007) and (2007-2008). In particular, we find that the economic indicator as measured by the degree of industrialization as measured by the value added/sales value (output) ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for metal and textile industries, small size and mixed firms, while contrary either the increasing trend continues for food industries or the declining trend turned into an increasing trend for all firms, chemical industries and medium size and large size and private firms. Moreover, as for the second economic indicator of capital intensity and productivity indicator as measured by capital/labour productivity indicator or ratio we find that for all firms the trend of value and growth rate of capital/labour ratio show a negative decreasing trend over the period (2005-2006) that turned into a positive increasing trend over the periods (2006-2007), (2007-2008) and (2005-2008). In particular, we find that the capital intensity and productivity indicator measured by capital/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for the chemical industries or the increasing trend turned into a declining trend for textile industries and medium size firms, whereas contrary either the increasing trend continues or the declining trend turned into an increasing trend for all firms, food and metal industries and small size and large size and private and mixed firms.

Moreover, we find that for all firms the trend of value and growth rate of the second economic indicator of capital intensity and productivity indicator measured by fixed capital/labour ratio measured by machinery and equipment/labour ratio show a negative decreasing trend over the periods (2005-2006), (2006-2007) and (2005-2008) that turned into a positive increasing trend over the period (2007-2008). In particular, we find that the capital intensity and productivity indicator measured by fixed capital/labour ratio measured by machinery and equipment/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for the chemical industries or the increasing trend turned into a declining trend for the medium size firms, whereas contrary either the increasing trend continues or the declining trend turned into an increasing trend for all firms, food, metal and textile industries, small size and large size, private and mixed firms. In addition, we find that for all firms the trend of value and growth rate of raw materials/labour ratio shows a positive increasing trend over the periods (2005-2006) and (2005-2008) that turned into a negative decreasing trend over the periods (2006-2007) and (2007-2008). In particular, we find that the raw materials/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for all firms, food and textile industries and medium size and mixed firms, while contrary either the increasing trend continues for the chemical industries, large size and private firms or the declining trend turned into an increasing trend for metal industries and small size firms. Moreover, we find that for all firms the trend of value and growth rate of wages/labour ratio show a negative decreasing trend over the periods (2005-2006) and (2005-2008) that turned into a positive increasing trend over the periods (2006-2007) and (2007-2008). In particular, we find that wages/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for food and textile industries and medium size firms, while contrary either the increasing trend continues for the chemical and metal industries and small size and private firms, or the declining trend turned into an increasing trend for all firms, large size and mixed firms. Moreover, we find that for all firms the trend of value and growth rate of sales value (output)/labour ratio show a negative decreasing trend over all the periods (2005-2006), (2006-2007), (2007-2008) and (2005-2008). In particular, we find that sales value (output)/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for all firms, food industries, medium size, and mixed firms or the increasing trend turned into a declining trend for private firms, while contrary either the increasing trend continues or the declining trend turned into an increasing trend for the chemical, metal, textile industries and small size and large size firms. Moreover, we find that for all firms the trend of value and growth rate of value added/labour ratio show a negative decreasing trend over the periods (2005-2006) and (2005-2008) that turned into a positive increasing trend over the periods (2006-2007) and (2007-2008). In particular, we find that the

value added/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for chemical and food industries, medium and large size and mixed firms, while contrary either the increasing trend continues for metal industries and small size firms or the declining trend turned into an increasing trend for all firms, textile and private firms- see Table 7 below. Moreover, we find that for all firms the trend of value and growth rate of other productivity indicators as measured by the wage productivity ratio as measured by sales/wage ratio show a negative decreasing trend over the period (2005-2006) that turned into a positive increasing trend over all the periods (2006-2007), (2007-2008) and (2005-2008). In particular, we find that the other productivity indicators as measured by the wage productivity ratio as measured by sales/wage ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for food industries and small size and mixed firms, while contrary either the increasing trend continues for metal industries or the declining trend turned into an increasing trend for all firms, chemical and textile industries and medium size and large size and private firms. Moreover, we find that for all firms the trend of value and growth rate of other productivity indicators as measured by the raw materials productivity as measured by the sales/raw materials ratio show a positive increasing trend over the period (2005-2006), that turned into a negative decreasing trend over the period (2006-2007) but that again turned into a positive increasing trend over the periods (2007-2008) and (2005-2008). In particular, we find that the other productivity indicators as measured by the raw materials productivity as measured by the sales/raw materials ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for food, metal and textile industries and small size and large size and mixed firms, while contrary either the increasing trend continues or the declining trend turned into an increasing trend for all firms, chemical industries and medium size and private firms. Moreover, as for the second set of indicators, the activity indicators we find that for all firms the trend of value and growth rate of activity and other productivity indicators as measured by fixed capital turn over ratio as measured by the sales/fixed capital ratio as measured by machinery and equipment show a positive increasing trend over the period (2005-2006), that turned into a negative decreasing trend over the period (2006-2007) but that again turned into a positive increasing trend over the periods (2007-2008) and (2005-2008). In particular, we find that the activity and other productivity indicators as measured by the fixed capital turn over ratio as measured by the sales/fixed capital ratio as measured by machinery and equipment vary across firms over the period (2005-2008), for instance, either the declining trend continues or the increasing trend turned into a declining trend for food industries and small size firms, while contrary either the increasing trend continues for mixed firms or the declining trend turned into an increasing trend for all firms, chemical, metal and textile

industries and medium size and large size and private firms. Moreover, we find that for all firms the trend of value and growth rate of activity and other productivity indicators as measured by the capital turn over ratio as measured by the sales/capital ratio show a positive increasing trend over the period (2005-2006), that turned into a negative decreasing trend over all the periods (2006-2007), (2007-2008) and (2005-2008). In particular, we find that the activity and other productivity indicators measured by the capital turn over ratio as measured by the sales/capital ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for medium size firms or the increasing trend turned into a declining trend for all firms, food industries and small size and private firms, while contrary either the increasing trend continues for textile industries or the declining trend turned into an increasing trend for chemical and metal industries and large size and mixed firms- see Table 8 below.

As for the third set of profitability indicators from Table 8, we find that for all firms the trend of value and growth rate of profitability that we measure by the rate of return on labour or profit/labour ratio show a positive increasing trend over the periods (2005-2006), (2006-2007) and (2005-2008) that turned into a negative declining trend over the period (2007-2008). In particular, we find that profit/labour ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for mixed firms or the increasing trend turned into a declining trend for all firms, chemical, food and textile industries, large size and private firms, while contrary either the increasing trend continues or the declining trend turned into an increasing trend for metal industries, small and medium size firms. In addition, we find that for all firms the trend of value and growth rate of profitability as measured by the rate of return on capital as measured by profit/capital ratio show a positive increasing trend over the periods (2005-2006) and (2006-2007) that turned into a negative decreasing trend over the periods (2007-2008) and (2005-2008). In particular, we find that profitability as measured by the rate of return on capital measured by profit/capital ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for medium size firms or the increasing trend turned into a declining trend for all firms, food and textile industries and private firms, while contrary either the increasing trend continues or the declining trend turned into an increasing trend for chemical and metal industries and small size and large size and mixed firms. Moreover, we find that for all firms the trend of value and growth rate of profitability measured by profit margin that we measure by profit/sales ratio show a negative decreasing trend over all the periods (2005-2006), (2007-2008) and (2005-2008). In particular, we find that profitability as measured by profit margin as measured by profit/sales ratio vary across firms over the period (2005-2008), for instance, either the declining trend continues for chemical and food industries, large size, medium size and private firms or the increasing trend turned into a declining trend for all firms, metal and textile industries and small size, while contrary the declining trend turned into an increasing trend only for mixed firms.

We find that in most cases the trend of these indicators seem to be more sensitive to differences in firm size, industry and sector. In particular, the industrial performance indicators that seem to be more sensitive to differences in firm size, industry and sector include economic indicator as measured by the degree of industrialization that we measure by the ratio of total value added as a percentage of total output measured by total sales value. Further to productivity indicator measured by capital productivity indicator measured by the ratio of total output measured by total sales value as a percentage of total capital, fixed capital productivity indicator measured by the ratio of output measured by total sales value as a percentage of fixed capital or machinery and equipment, wage productivity indicator that we measure by the total output measured by total sales value as a percentage of total wage. In addition to the activity indicators or ratios measured by fixed capital turnover ratio measured by the ratio of total sales value as a percentage of fixed capital and capital turnover ratio measured by the ratio of total sales value as a percentage of total capital, in addition to profitability indicator measured by the rate of return on capital measured by the ratio of profit as a percentage to capital. We find that the industrial performance indicators that seem to be to some extent sensitive to differences in firm size but less sensitive to industry and sector includes economic or capital intensity level indicator measured by both the ratio of total capital as a percentage to total labour and the ratio of fixed capital or total spending in machinery and equipment as a percentage to total labour. Moreover, we find that the industrial performance indicator that seems to be sensitive to only differences in industry is the raw materials productivity indicator measured by the ratio of total output measured by total sales value as a percentage to total spending on raw material. We find that the industrial performance indictors that seem to be insensitive to differences in firm size, industry and sector include labour productivity indicator measured by the ratio of total value added as a percentage to total labour and profitability indicators that we define by profit/labour ratio and profit margin indicator defined by the ratio of profit as a percentage to total sales value. These results imply that in most cases an increase in skill level -share of high skill in total employment- firm size and industry most probably leads to improvement in most of industrial performance indicators-see Tables 7-8 below.

Table 7 – Assessment of the value, trend and growth rates of industrial performance: economic, activity, labour productivity, output/labour and capital/labour ratios and other productivity indicators across firms (2005-2008)

Variables		**Value (2005-2008)**				**Trend (2005-2008)**				**Growth rate (2005-2008)**			
Average ratio of	Group of firms	2005	2006	2007	2008	2005-2006	2006-2007	2007-2008	2005-2008	2005-2006	2006-2007	2007-2008	2005-2008
1. Economic indicators													
The degree of industrialization = value added/ output (sale value)	Chemical	20.071384	0.1006944	0.1102117	0.121095	-	+	+	-	-99	9	10	-99
	Food	5.59262	5.7751745	7.4236966	7.7370768	+	+	+	+	3	29	4	38
	Metal	0.0309524	0.0166667	0.1135593	0.0888889	-	+	-	+	-46	581	-22	187
	Textile	0.1262011	0.1229581	0.1379861	0.1255524	-	+	-	-	-3	12	-9	-1
	Large	25.063934	0.0877692	0.0970537	0.1137513	-	+	+	-	-100	11	17	-100
	Medium	7.4804304	7.243592	7.4348101	7.7427771	-	+	+	+	-3	3	4	4
	Small	0.0627458	0.0632965	0.1214039	0.1166114	+	+	-	+	1	92	-4	86
	Private	12.28653	2.6815389	3.1682737	3.3004401	-	+	+	-	-78	18	4	-73
	Mixed	0.0727273	0.0725	0.075	0.0733333	-	+	-	+	0	3	-2	1
	All firms	6.4552894	1.5038734	1.9463634	2.0181533	-	+	+	-	-77	29	4	-69
2. Activity and labour productivity indicators													
Capital/ labour	Chemical	35065602	27590847	20278975	16777192	-	-	-	-	-21	-27	-17	-52
	Food	7.16E+09	6.10E+09	6.68E+09	7.52E+09	-	+	+	+	-15	9	13	5
	Metal	30876818	74171574	81460349	104421212	+	+	+	+	140	10	28	238
	Textile	10757338	11308723	9320350.8	9304595.7	+	-	-	-	5	-18	0	-14
	Large	18022260	44082391	7016133	11853455	+	-	+	-	145	-84	69	-34
	Medium	716288.06	540146.61	4118685.8	2901363.1	-	+	-	+	-25	663	-30	305
	Small	4.59E+09	5.01E+09	5.50E+09	5.83E+09	+	+	+	+	9	10	6	27
	Private	2.39E+09	2.28E+09	2.08E+09	2.29E+09	-	-	+	-	-4	-9	10	-4
	Mixed	153115039	212744727	108623182	117178164	+	-	+	-	39	-49	8	-23
	All firms	1.809E+09	1.553E+09	1.697E+09	1.912E+09	-	+	+	+	-14	9	13	6
Fixed capital (machinery and. equipment)./ Labour	Chemical	17324619	14756079	13091702	11310615	-	-	-	-	-15	-11	-14	-35
	Food	296053860	68495853	59997873	63588812	-	-	+	-	-77	-12	6	-79
	Metal	32035906	39615035	41916373	102960921	+	+	+	+	24	6	146	221
	Textile	2866267.3	2503114.8	37533.295	39332.76	-	-	+	-	-13	-99	5	-99
	Large	260069994	51927232	41157115	47809051	-	-	+	-	-80	-21	16	-82
	Medium	84350.355	60784.395	3060039.9	1746163.8	-	+	-	+	-28	4934	-43	1970
	Small	24976660	28926310	27914835	44197977	+	-	+	+	16	-3	58	77
	Private	3438151.1	3258447.2	4053537.4	10617005	-	+	+	+	-5	24	162	209
	Mixed	760056666	283521984	249015472	273580008	-	-	+	-	-63	-12	10	-64
	All firms	87070163	31342520	28760870	44474920	-	-	+	-	-64	-8	55	-49
Raw materials/ labour	Chemical	2871098.1	97839439	100277944	107446906	+	+	+	+	3308	2	7	3642
	Food	88134391	9517892.2	26412145	14109863	-	+	-	-	-89	177	-47	-84
	Metal	9684090.9	37673071	15697858	27849382	+	-	+	+	289	-58	77	188
	Textile	1472742.7	8473466	9432995.2	1311518.5	+	+	-	-	475	11	-86	-11
	Large	78630305	116823438	141977429	153140881	+	+	+	+	49	22	8	95
	Medium	526713.27	653338.89	4091163.3	2391839.4	+	+	-	+	24	526	-42	354
	Small	5617402.1	15395691	8733551.6	10354531	+	-	+	+	174	-43	19	84
	Private	5518075	60875381	64930925	67173818	+	+	+	+	1003	7	3	1117
	Mixed	213506237	6285777.8	54637414	22482133	-	+	-	-	-97	769	-59	-89
	All firms	25540581	38375967	37955236	37679417	+	-	-	+	50	-1	-1	48
Wage/ Labour	Chemical	629661.54	691335.32	1107005.7	1202982.3	+	+	+	+	10	60	9	91
	Food	19795120	4465405.3	5182546.5	5001834	-	+	-	-	-77	16	-3	-75
	Metal	2795004.4	7412864.2	7561777.4	8655813.8	+	+	+	+	165	2	14	210
	Textile	1123823.6	1174157	10385.944	7701.6136	+	-	-	-	4	-99	-26	-99
	Large	17960782	4505029.2	3964134.6	4244171.8	-	-	+	-	-75	-12	7	-76
	Medium	53597.363	68865.449	416449.87	258538.56	+	+	-	+	28	505	-38	382
	Small	1290975.4	2367999.3	2820244.4	4674367.5	+	+	+	+	83	19	66	262
	Private	1827576.6	1953272.4	2047724.2	2477402.8	+	+	+	+	7	5	21	36
	Mixed	44890563	7038915.8	7394609.9	9456880.8	-	+	+	-	-84	5	28	-79
	All firms	6085902.4	3435940.5	3465428.9	3717082.9	-	+	+	-	-44	1	7	-39
Sales value (output)/ labour	Chemical	2965521.1	62897297	50687940	55577289	+	-	+	+	2021	-19	10	1774
	Food	948316463	882596205	729683552	623900429	-	-	-	-	-7	-17	-14	-34
	Metal	65918758	43718037	101317367	120345041	-	+	+	+	-34	132	19	83
	Textile	1667595	3069766.2	956358.61	1035369.3	+	-	+	-	84	-69	8	-38
	Large	143338675	119495935	110775961	116574335	-	-	+	-	-17	-7	5	-19
	Medium	1.15E+09	893753071	735194023	578678320	-	-	-	-	-22	-18	-21	-50
	Small	9459741.1	168685305	9030811.2	23463531	+	-	+	+	1683	-95	160	148
	Private	337535170	361251148	267733421	250215178	+	-	-	-	7	-26	-7	-26
	Mixed	316187014	60302554	57519586	43154592	-	-	-	-	-81	-5	-25	-86
	All firms	254717084	248070326	220661304	200214532	-	-	-	-	-3	-11	-9	-21
Value added/ labour	Chemical	2551317.2	955660.37	1313488.7	1058510.2	-	+	-	-	-63	37	-19	-59
	Food	34483247	5451257.3	5644107.6	4247107.3	-	+	-	-	-84	4	-25	-88
	Metal	1477272.7	1851851.9	7790697.7	23333333	+	+	+	+	25	321	200	1479
	Textile	316276.81	285201.47	444191.11	482803.84	-	+	+	+	-10	56	9	53
	Large	36327013	6253965	6471635.7	4749855.5	-	+	-	-	-83	3	-27	-87
	Medium	3795.4275	4626.0202	1069155.8	762380.47	+	+	-	+	22	23012	-29	19987
	Small	1495991.8	1884495.9	2709645.6	5814842.9	+	+	+	+	26	44	115	289
	Private	1486836.5	859713.02	1576540.1	2743335.1	-	+	+	+	-42	83	74	85
	Mixed	68965517	12500000	12931034	9482758.6	-	+	-	-	-82	3	-27	-86
	All firms	9707028.4	2135992.8	3798121.3	7280438.6	-	+	+	-	-78	78	92	-25

Source: Firm Survey (2010): own calculation from the firm survey (2010)

Table –8 Assessment of the value, trend and growth rates of industrial performance: Activity, other productivity and profitability indicators across firms (2005-2008)

Variables		Value (2005-2008)				Trend (2005-2008)				Growth rate (2005-2008)			
Average ratio of	Group of firms	2005	2006	2007	2008	2005-2006	2006-2007	2007-2008	2005-2008	2005-2006	2006-2007	2007-2008	2005-2008
3. Activity and other productivity indicators													
Fixed capital turnover ratio=sale/ sale value/ fixed capital (machinery and equipment)	Chemical	2.8912123	495.92478	308.19507	366.82629	+	-	+	+	17053	-38	19	12588
	Food	3.1793517	189.03297	146.05162	114.63459	+	-	-	+	5846	-23	-22	3506
	Metal	0.408299	0.8018738	0.648209	0.8518113	+	-	+	+	96	-19	31	109
	Textile	101.48658	60.764981	61.229179	87.570441	-	+	+	-	-40	1	43	-14
	Large	1.8379	673.70374	449.75099	451.41571	+	-	+	+	36556	-33	0	24461
	Medium	3.4770759	2.9621226	3.2838275	134.22139	-	+	+	+	-15	11	3987	3760
	Small	30.012525	160.39301	126.72865	116.94158	+	-	-	+	434	-21	-8	290
	Private	17.22597	353.64104	242.29702	273.28094	+	-	+	+	1953	-31	13	1486
	Mixed	0.1603258	0.3773134	0.4740032	0.496713	+	+	+	+	135	26	5	210
	All firms	26.991361	186.63115	129.03102	142.47078	+	-	+	+	591	-31	10	428
Capital turnover ratio= sale value /capital	Chemical	42.418878	40.067628	3.634055	59.389793	-	-	+	+	-6	-91	1534	40
	Food	412.50789	498.51296	499.94462	255.81401	+	+	-	-	21	0	-49	-38
	Metal	0.4260684	0.4852564	0.4158425	0.6116496	+	-	+	+	14	-14	47	44
	Textile	0.1639614	1.1928782	3.3614254	8.2609911	+	+	+	+	628	182	146	4938
	Large	67.82426	60.273972	6.1373149	44.09251	-	-	+	-	-11	-90	618	-35
	Medium	573.8511	462.21815	444.30504	259.79308	-	-	-	-	-19	-4	-42	-55
	Small	1.0437791	68.812585	0.8258962	0.6976534	+	-	-	-	6493	-99	-16	-33
	Private	167.38012	194.48088	145.13254	111.76126	+	-	-	-	16	-25	-23	-33
	Mixed	2.6348545	0.5323247	3.8765243	11.515423	-	+	+	+	-80	628	197	337
	All firms	113.8792	135.06468	126.83899	81.019111	+	-	-	-	19	-6	-36	-29
Wage productivity ratio= output/(sale value)/wage	Chemical	8.3525744	8.1943495	7.3845158	361.40226	-	-	+	+	-2	-10	4794	4227
	Food	428.41408	552.93182	400.66736	344.83311	+	-	-	-	29	-28	-14	-20
	Metal	4.9500291	5.7200371	5.9344161	12.735474	+	+	+	+	16	4	115	157
	Textile	523.82575	315.64078	506.53952	548.33265	-	+	+	+	-40	60	8	5
	Large	9.4032343	10.088306	9.3580525	9.8078386	+	-	+	+	7	-7	5	4
	Medium	10.118612	14.996222	8.6892371	511.03983	+	-	+	+	48	-42	5781	4950
	Small	496.53461	614.09712	557.16857	538.03343	+	-	-	+	24	-9	-3	8
	Private	242.53064	253.70029	205.28462	379.92113	+	-	+	+	5	-19	85	57
	Mixed	2.4749747	4.802963	4.7386977	3.6878688	+	-	-	+	94	-1	-22	49
	All firms	241.38561	220.62175	230.13145	316.82587	-	+	+	+	-9	4	38	31
Raw materials productivity ratio= output/(sale value)/raw materials	Chemical	1.472792	1.5531448	1.3339254	366.07809	+	-	+	+	5	-14	27344	24756
	Food	6.8706046	1523.3263	157.43672	132.15185	+	-	-	+	22072	-90	-16	1823
	Metal	1.5252941	1.3110383	73.819865	2.4578007	-	+	-	+	-14	5531	-97	61
	Textile	2.0123894	2.0076766	4.1239329	2.1136204	-	+	-	+	0	105	-49	5
	Large	1.8617158	2.8742128	2.3465453	2.0572816	+	-	-	+	54	-18	-12	11
	Medium	2.5102906	2.0460816	154.59166	758.66946	-	+	+	+	-18	7455	391	30122
	Small	5.4970686	1521.3296	18.090003	4.4274845	+	-	-	-	27575	-99	-76	-19
	Private	3.8347064	549.06214	53.093879	255.13267	+	-	+	+	14218	-90	381	6553
	Mixed	0.6954618	4.7421652	4.0867543	1.1633541	+	-	-	+	582	-14	-72	67
	All firms	2.97027	382.04954	59.178611	125.70034	+	-	+	+	12762	-85	112	4132
4. Profitability indicators													
Rate of return on labour= profit/labour	Chemical	325003.77	97520339	93381463	89415111	+	-	-	+	29906	-4	-4	27412
	Food	16073000	16556605	15371532	8457780.9	+	-	-	-	3	-7	-45	-47
	Metal	25195354	10424630	42266973	45856265	-	+	+	+	-59	305	8	82
	Textile	928346.78	512349.74	226633.83	237267.99	+	+	-	+	-45	-56	5	-74
	Small	14843443	3943959.6	1559333	7393518.3	+	-	+	+	-127	-60	374	-150
	Medium	246042.07	280699.08	261740.38	377443.01	+	-	+	+	14	-7	44	53
	Large	30615658	107746075	119654268	116398986	+	+	-	+	252	11	-3	280
	Private	1343693.4	56024755	59488296	55206716	+	+	-	+	4069	6	-7	4009
	Mixed	62279128	10959241	10342936	8606965	-	-	-	-	-82	-6	-183	-114
	All firms	10166253	30997306	37698334	35872972	+	+	-	+	205	22	-5	253
Rate of return on capital= profit/capital	Chemical	7.202629	6.792908	5.1351797	8.9627444	-	-	+	+	-6	-24	75	24
	Food	2.2030291	10.639528	10.380229	15.224402	+	-	-	-	383	-2	-247	-791
	Metal	0.0336182	0.0365385	0.0194139	0.0901709	+	-	+	+	9	-47	364	168
	Textile	0.358709	2.3015254	0.2610921	0.2539136	-	+	-	-	-742	-111	-197	-171
	Large	10.3743	9.2316877	7.0692848	8.0630912	-	-	+	-	-11	-23	14	-22
	Medium	13.761543	10.120505	9.8050205	7.547615	-	-	-	-	-26	-3	-177	-155
	Small	6.6239792	0.6008153	0.0492431	0.0834129	+	-	+	+	-109	-92	69	-101
	Private	4.3952252	6.8602373	6.0800742	0.1484943	+	-	-	-	56	-11	-102	-103
	Mixed	0.3483543	0.0733435	1.231029	1.2917988	-	-	+	+	-121	1578	-205	271
	All firms	2.4494963	3.7918623	3.9489787	1.6063501	+	+	-	-	55	4	-141	-166
Profit margin= profit/sale	Chemical	4.9863121	4.0622007	2.6593402	2.4372959	-	-	-	-	-19	-35	-8	-51
	Food	4444.0867	4000.932	4000.7488	3334.3731	-	-	-	-	-10	0	-17	-25
	Metal	0.0272396	0.1014987	0.1787782	0.2703077	+	+	-	-	-473	76	-251	892
	Textile	3.7304507	2.0300487	0.0842857	0.2035356	+	+	-	+	-46	-104	-341	-95
	Large	471.82625	0.9103777	0.4437194	0.3052073	-	-	-	-	-100	-51	-31	-100
	Medium	10.019226	6.4150969	5.6685649	4.5480634	-	-	-	-	-36	-12	-20	-55
	Small	3998.7518	4000.0724	3636.4011	3333.2799	+	-	-	-	0	-9	-8	-17
	Private	1741.3817	1430.6505	1178.2029	1054.1797	-	-	-	-	-18	-18	-11	-39
	Mixed	3.8074523	0.0536275	0.0249647	0.0988276	+	-	+	+	-101	-53	296	-103
	All firms	1111.3288	1000.7664	1000.9178	834.08414	-	+	-	-	-10	0	-17	-25

Source: Own calculation based on the firm survey (2010).

d. Low skill level and declining performance of manufacturing industrial firms

The findings from the firm survey (2010) and Table 9 below support our argument that the low skill levels may contribute to declining industrial performance indicators: economic, activity, profitability and labour productivity across firms as we explained above. Table 6

below shows that the low skill level is indicated by firms among the important problems that are hindering industrial performance and contribution towards economic development in Sudan.[45] For instance, we find that from the perspective of all respondent firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to the industrial needs, interruption and inadequate availability and high costs of electricity and water, lack of raw materials, inadequate infrastructure, weak maintenance capability and lack of spares parts, inadequate skill and lack of trained labour force, weak industrial awareness, weak and narrow marketing opportunities, weak and inadequate economic visibility studies, inadequate management and organizational facilities and inadequate transportation equipments respectively- see Table 9 below.[46] For chemical industries the most important problems are: interruption and inadequate availability and high costs of electricity and water, spread of routine and bureaucracy and slow procedures related to industrial needs, lack of raw materials, inadequate finance and inappropriate conditions for industrial development, inadequate infrastructure, weak industrial awareness, inadequate skill and lack of trained labour force, weak maintenance capability and lack of spares parts, weak and narrow marketing opportunities and inadequate management and organizational facilities respectively.[47] For food industries the most important problems are: spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate finance and inappropriate conditions for industrial development, weak maintenance capability and lack of spares parts, inadequate infrastructure, inadequate skill and lack of trained labour force, weak industrial awareness, weak and narrow marketing opportunities and lack of raw materials respectively.[48] For metal industries the most important problems are: inadequate skill and lack of trained labour force, inadequate finance and inappropriate conditions for industrial development, lack of raw materials, inadequate infrastructure, weak maintenance capability and lack of spares parts, weak industrial awareness, inadequate management and organizational facilities and spread of routine and bureaucracy and slow procedures related to industrial needs respectively.[49] For textile industries the most important problems are: inadequate finance and inappropriate conditions for industrial development, lack of raw materials, interruption and inadequate availability and high costs of electricity and water, weak and narrow marketing opportunities, inadequate skill and lack of trained labour force, spread of routine and bureaucracy and slow procedures related to industrial needs, weak maintenance capability and

[45] For instance, the inadequate skill and lack of trained labour force is important problem that reported by 75%, 76%, 68%, 100%, 60%, 91%, 69% and 60% of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.
[46] As indicated by 86%, 85%, 84%, 78%, 76%, 75%, 75%, 73%, 67%, 61%, 57% and 52% of all respondents firms respectively.
[47] As indicated by 89%, 89%, 86%, 84%, 81%, 78%, 76%, 76%, 70% and 65% of all respondents chemical firms respectively.
[48] As indicated by 89%, 86%, 82%, 75%, 71%, 68%, 68% and 64% and 61% of all respondents food firms respectively.
[49] As indicated by 100%, 100%, 89%, 89%, 78%, 78%, 67% and 67% of all the respondents metal firms respectively.

lack of spares parts and weak industrial awareness respectively.[50] For large size firms the most important problems are: inadequate skill and lack of trained labour force, weak maintenance capability and lack of spares parts, inadequate finance and inappropriate conditions for industrial development, lack of raw materials, interruption and inadequate availability and high costs of electricity and water, spread of routine and bureaucracy and slow procedures related to industrial needs, weak industrial awareness, inadequate management and organizational facilities, inadequate infrastructure and weak and narrow marketing opportunities respectively.[51] For medium size firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate infrastructure, lack of raw materials, narrow marketing opportunities, weak industrial awareness, inadequate skill and lack of trained labour force and weak maintenance capability and lack of spares parts respectively.[52] For small size firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate infrastructure, lack of raw materials, weak maintenance capability and lack of spares parts, weak industrial awareness, weak and narrow marketing opportunities, weak and inadequate economic visibility studies and inadequate skill and lack of trained labour force respectively.[53]

Hence, our results from Table 9 and firm survey (2010) are consistent with the findings in developing countries and Sudanese literature that indicate several problems of industrialisation in Sudan (El-Sayed, 1998 and Abd-Alsalam, 2006) similar to those in the typically developing countries (Ismail, 2007). Different from the studies in the Sudanese literature (El-Sayed, 1998 and Abd-Alsalam, 2006) which provide somewhat general overview concerning the problems of industrialisation in Sudan, an interesting and novel element in our analysis is that our findings is based on recent micro primary data based on the firm survey (2010) and the follow-up interviews with firms managers and we present new and a more elaborate interpretation of the main problems of industrialisation in Sudan from the perspective of the different industrial firms considering the opinions of a more diversified sample of industrial firms defined by industry and size as we explained in Table 9 below.[54]

[50] As indicated by 100%, 100%, 80%, 80%, 60%, 60%, 60%, 60% and 60% of all the respondents textile firms respectively.
[51] As indicated by 91%, 91%, 88%, 84%, 84%, 84%, 81%, 75%, 72%, and 66% of all respondents large size firms respectively.
[52] As indicated by 88%, 88%, 85%, 81%, 77%, 73%, 73%, 69%, and 65% of all the respondents medium size firms respectively.
[53] As indicated by 85%, 85%, 85%, 80%, 75%, 65%, 65%, 65%, 65% and 60% of all respondents small size firms respectively.
[54] See for instance, El-Sayed (1998:184-188), Abd-Alsalam (2006: 28-32) and Ismail (2007: 206-209).

Table 6- The factors constraining improvement of industrial firms' performance and economic development in Sudan (2008)

	All firms	Industry				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Inadequate finance and inappropriate conditions for industrial development	86%	84%	82%	100%	100%	88%	88%	85%
Spread of routine and bureaucracy and slow procedures related to industrial needs	85%	89%	89%	67%	60%	84%	88%	85%
Interruption and inadequate availability and high costs of electricity and water	84%	89%	86%	56%	80%	84%	85%	85%
Lack of raw materials.	78%	86%	61%	89%	100%	84%	77%	75%
In adequate infrastructure	76%	81%	71%	89%	40%	72%	81%	80%
Weak maintenance capability and lack of spares parts.	75%	76%	75%	78%	60%	91%	65%	65%
Inadequate skill and lack of trained labour force	75%	76%	68%	100%	60%	91%	69%	60%
Weak industrial awareness	73%	78%	68%	78%	60%	81%	73%	65%
Weak and narrow marketing opportunities	67%	70%	64%	56%	80%	66%	73%	65%
Weak and in adequate economic visibility studies	61%	65%	61%	56%	40%	59%	62%	65%
Inadequate management and organizational facilities	57%	65%	46%	67%	40%	75%	46%	45%
Inadequate transportation equipments	52%	51%	46%	67%	60%	59%	50%	45%

Source: Own calculation based on the firm survey (2010).

Therefore, our findings in this section verify the first hypothesis that high skill requirements and low skill levels–due to high share of unskilled workers– lead to skills mismatch and probably contribute to industrial performance and productivity decline across firms. We find that the performance of the industrial firms is most probably significantly undermined by the shortage of skilled workers and also by the lack of entrepreneur perspective. In the next sections we examine the second and third hypotheses.

5. Upskilling, improving industrial performance and relationships between required education (occupation), attained/actual education, experience and average wages

Before examining the second and third hypotheses, it is useful to briefly show the importance of upskilling, because explaining this can be used to prevent the decline in labour productivity and industrial performance indicators and to enhance the complementary relationships between skill, technology and upskilling across firms.

5.1 Upskilling and improving performance of manufacturing industrial firms

The findings from the firm survey (2010) presented in Tables 6-9 above support our argument that the low skill levels may contribute to the declining of labour productivity and other industrial performance indicators including economic, productivity, activity and profitability indicators across firms as we explained above. These findings imply that improving skill level is important factors for facilitating improvement of labour productivity and other industrial performance indicators. Table 10 below indicates upskilling or improving skill level and adequate availability of skill and trained labour force among the important factors facilitating improvement of industrial firms' performance and contribution towards economic development in Sudan.[55] For instance, we find that from the perspective of all respondent

[55] For instance, improving skill level and adequate availability of skill and trained labour force is one important factor facilitating improvement of industrial firms' performance and contribution towards economic development that reported by 85%, 86%, 79%, 100%, 80%, 100%, 81%, and 70% of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.

firms the most important factors facilitating improvement are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of maintenance capability and spares parts and avoiding of routine and bureaucracy and speed up the procedures related to industrial needs. In addition to improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of skill and trained labour force, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of management and organizational facilities, improving and enhancing adequate availability of transportation equipments and improving and enhancing adequate availability of economic visibility studies- see Table 10 below.[56] From the perspective of chemical firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of maintenance capability and spares parts and improving and enhancing adequate availability of marketing opportunities. In addition to improving and enhancing adequate availability of management and organizational facilities, improving and enhancing adequate availability of skill and trained labour force, avoiding of routine and bureaucracy and speed up the procedures related to industrial needs, improving and enhancing adequate availability of electricity and water with cheap and subsidised price.[57] From the perspective of food firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, avoiding of routine and bureaucracy and speed up the procedures related to industrial needs and improving and enhancing adequate availability of industrial awareness. In addition to improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of maintenance capability and spares parts, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of marketing opportunities and improving and enhancing adequate availability of skill and trained labour force respectively.[58] From the perspective of metal firms the most important factors are: improving and enhancing adequate availability of skill and trained labour force, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of maintenance

[56] As indicated by 91%, 90%, 90%, 89%, 87%, 86%, 86%, 85%, 85%, 81%, 75% and 72% of all respondents firms respectively.
[57] As indicated by 92%, 92%, 92%, 92%, 92%, 89%, 89%, 86%, 86% and 84% of all chemical respondents firms respectively.

capability and spares parts, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of infrastructure and avoiding of routine and bureaucracy and speed up the procedures related to industrial needs. In addition to improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of management and organizational facilities and improving and enhancing adequate availability of transportation equipments respectively.[59] From the perspective of textile firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of electricity and water with cheap and subsidised price and improving and enhancing adequate availability of skill and trained labour force. In addition to improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of maintenance capability and spares parts, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of management and organizational facilities, avoiding of routine and bureaucracy and speed up the procedures related to industrial needs and improving and enhancing adequate availability of infrastructure respectively.[60] From the perspective of large size firms the most important factors are: improving and enhancing adequate availability of skill and trained labour force, improving and enhancing adequate availability of management and organizational facilities, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of maintenance capability and spares parts, improving and enhancing adequate availability of industrial awareness and improving and enhancing adequate availability of infrastructure. In addition to avoiding of routine and bureaucracy and speed up the procedures related to industrial needs, improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of transportation equipments and improving and enhancing adequate availability of economic visibility studies respectively.[61] From the perspective of medium size firms the most important factors are: improving and enhancing adequate availability of industrial awareness, avoiding of routine and bureaucracy and speed up the procedures related to industrial needs, improving and enhancing adequate availability of finance and appropriate

[58] As indicated by 89%, 89%, 86%, 86%, 82%, 82%, 82%, 82 and 79% of all food respondents firms respectively.
[59] As indicated by 100%, 100%, 100%, 100%, 89%, 89%, 89%, 89%, 89% and 89% of all metal respondents firms respectively.
[60] As indicated by 100%, 100%, 100%, 80%, 80%, 80%, 80%, 80%, 80% and 60% of all textile respondents firms respectively.
[61] As indicated by 100%, 100%, 100%, 97%, 97%, 97%, 94%, 91%, 88%, 88%, 88% and 84% of large size firms respectively.

conditions for industrial development, improving and enhancing adequate availability of raw materials and improving and enhancing adequate availability of skill and trained labour force. In addition to improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of maintenance capability and spares parts, improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of marketing opportunities and improving and enhancing adequate availability of management and organizational facilities and availability of transportation equipments.[62] From the perspective of small size firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of maintenance capability and spares parts, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of raw materials and improving and enhancing adequate availability of infrastructure. In addition to avoiding of routine and bureaucracy and speed up the procedures related to industrial needs, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of management and organizational facilities, improving and enhancing adequate availability of economic visibility studies, improving and enhancing adequate availability of transportation equipments and improving and enhancing adequate availability of skill and trained labour force respectively.[63]

Table 10- The factors facilitating improvement of industrial firms' performance and economic development in Sudan (2008)

	All firms	Industry				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Improving and enhancing adequate availability of finance and appropriate conditions for industrial development	91%	92%	89%	89%	100%	97%	85%	95%
Improving and enhancing adequate availability of raw materials.	90%	92%	82%	100%	100%	100%	85%	85%
Improving and enhancing adequate availability of industrial awareness	90%	92%	86%	100%	80%	97%	88%	85%
Improving and enhancing adequate availability of maintenance capability and spares parts.	89%	92%	82%	100%	80%	97%	81%	90%
Avoiding of routine and bureaucracy and speed up the procedures related to industrial needs	87%	86%	89%	89%	80%	91%	88%	85%
Improving and enhancing adequate availability of infrastructure	86%	92%	82%	89%	60%	94%	81%	85%
Improving and enhancing adequate availability of electricity and water with cheap and subsidised price	86%	84%	86%	89%	100%	88%	81%	95%
Improving and enhancing adequate availability of skill and trained labour force	85%	86%	79%	100%	80%	100%	81%	70%
Improving and enhancing adequate availability of marketing opportunities	85%	89%	82%	78%	80%	88%	81%	90%
Improving and enhancing adequate availability of management and organizational facilities	81%	89%	68%	89%	80%	100%	65%	75%
Improving and enhancing adequate availability of transportation equipments	75%	73%	75%	89%	60%	88%	62%	75%
Improving and enhancing adequate availability of economic visibility studies	72%	76%	71%	67%	60%	84%	58%	75%

Source: Own calculation based on the firm survey (2010).

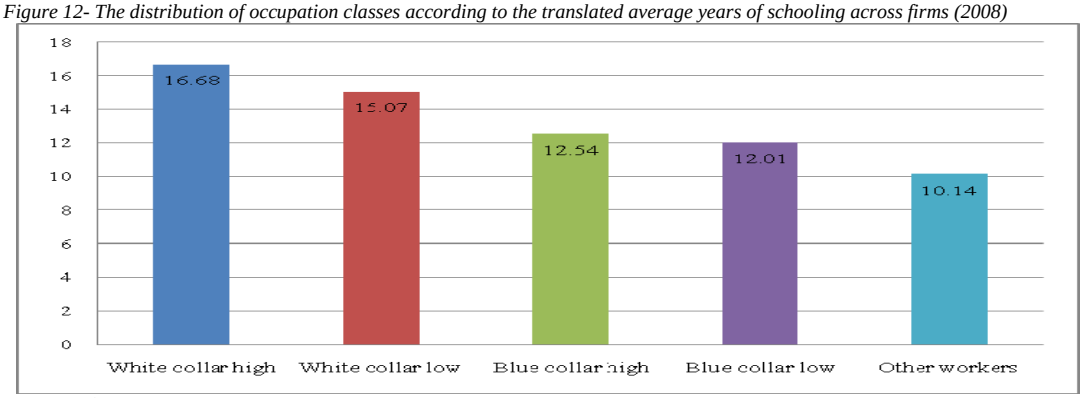
[62] As indicated by 88%, 88%, 85%, 85%, 81%, 81%, 81%, 81%, 81%, 65% and 62% of medium firms respectively.
[63] As indicated by 95%, 95%, 90%, 90%, 85%, 85%, 85%, 85%, 75%, 75%, 75% and 70% of small firms respectively.

5.2 *Relationships between the required education (occupation), attained/actual education, experience and average wages*

Based on the above findings, in this section we examine a part of the second hypothesis that an increase in skill levels and firm size lead to improved relationships between actual and required education, and between actual education, required education, experience and wages across firms.

We begin with the relationship between occupation and education. Using the above definitions of occupation and education/actual and required education respectively, we translate the required qualifications for each of the occupation groups into average years of schooling and use the OLS regression, assuming that the required schooling in each occupation class is dependent on the actual/attained education. Our findings in Table 11 and Figure 12 below illustrate that improvement in occupational status (measured by the required education) is positively and significantly correlated with education (measured by actual/attained education) across all firms. In addition, Table 11 illustrates that an increase in firm size and industry level lead to improved relationships between required and actual education. For instance, the required education appears to be more sensitive to and increasing in actual education within both large size and chemical and food firms, and more sensitive within all firms. This result is plausible since the skill level – share of high skilled measured by educational attainment – is higher within large size and chemical and food firms compared to metal and textile, medium and small size firms – see Figure 5 above. This is also probably because large size firms are more prevalent in the chemical and food industries– see Table 5 above – and may have more consistent recruitment strategies. These results confirm our earlier observations that skill levels and requirements (actual and required education) are non-homogenous across firms and are determined by size and industry.

Figure 12- The distribution of occupation classes according to the translated average years of schooling across firms (2008)



Source: Firm Survey (2010)

Concerning the relationship between education, occupation and experience, Table 11 above shows that average years of experience are positively correlated and increasing in education and occupation i.e. attained/actual and required education respectively. This result is consistent

with Figure 10 above, and probably implies that skill indicators –education and experience – are complementing rather than substituting each other.

Table 11 - Required and actual/ attained education and experience across firms (2008)

		Coefficient (t-value)			R^2	N[64]
Independent Variable		Actual education	Required education	Constant		
Dependent Variable	Group of firms and skill					
Required education All groups (High, medium and Low)	All firms	0.873** (25.172)		2.101 (4.691)	0.759	74
	Large	0. 905** (16.672)		1.849 (2.627)	0.772	26
	Medium	0.864 ** (14.592)		2.291 (2.999)	0.766	18
	Small	0.825 ** (11.761)		2.297 (2.554)	0.742	15
	Chemical	0.883** (15.390)		1.895 (2.540)	0.731	27
	Food	0.879** (15.816)		2.037 (2.850)	0.777	21
	Metal	0.814 ** (9.387)		3.262 (2.913)	0.793	7
	Textile	0.875** (8.338)		1.749 (1.316)	0.842	4
Average years experience All firms	All firms	0.412** (3.469)		0.767 (0.505)	0.056	73
	Large	0.539** (3.059)		-0.521 (-0.231)	0.102	26
	Medium	0.388* (1.576)		0.777 (0.245)	0.390	18
	Small	0.295* (1.429)		2.232 (0.852)	0.306	15
	Chemical	0.274* (1.452)		3.424 (1.404)	0.023	27
	Food	0.617** (4.010)		-3.065 (-1.568)	0.185	21
	Metal	0.371 (0.940)		2.131 (0.423)	0.032	7
	Textile	0.068 (0.164)		3.810 (0.724)	0.003	4
	All firms		0.641** (4.260)	-1.810 (-0.892)	0.089	71
	Large		0.439** (2.407)	0.880 (0.354)	0.070	26
	Medium		0.566* (1.606)	-0.697 (-0.145)	0.043	18
	Small		1.156** (4.311)	-8.273 (-2.369)	0.288	15
	Chemical		0.465* (1.875)	1. 528 (0.458)	0.039	27
	Food		0.658** (3.305)	-3. 490 (-1.304.)	0.148	21
	Metal		1.402** (3.621)	-12.262 (-2.290)	0.373	7
	Textile		0628 (1.034)	-1.047 (-0.129)	0.106	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

Table 12 below illustrates a considerable variation in the distribution of average wages amongst high, medium and low skill – educational and occupational – levels across firms. When using the occupational rather than the educational definition, the distribution of wages

[64] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Nour (2011) above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and

shows less fluctuation across firms. Therefore, the effect of occupation/required education on the distribution of average wages across firms seems to be less sensitive to differences in firm size and industry. In contrast, when using the educational definition, we observe that the effect of the actual/attained education on the distribution of average wages across firms seems to be more sensitive to differences in firm size and industry. Our interpretation of the observed differences across firms implies the presence of significant wage differential, the lack of a coherent, homogeneous, unified and sound wage policy and the lack of systematic and consistent recruitment strategies across firms that most probably related to the lack of systematic regulations to organise the labour market in Sudan

Table 12- Differences in the distribution of average wages defined by firm size and industry level and sector (2008)

(a) Skill variables: Education											
Characteristics	All firms	Industry/ activity				Size			Sector		
Wages defined by skill level		Chemical	Food	Metal	Textile	Large	Medium	Small	Public	Private	Mixed
High educated/ white collar high											
4,001- 5,000	1%	0%	0%	13%	0%	3%	0%	0%	0%	2%	0%
3,001- 4,000	4%	6%	0%	13%	0%	7%	0%	5%	0%	5%	0%
2,001- 3,000	13%	19%	11%	0%	0%	10%	13%	16%	0%	11%	40%
1,001- 2,000	46%	41%	44%	50%	80%	50%	48%	37%	0%	45%	60%
0,200- 1,000	36%	34%	44%	25%	20%	30%	39%	42%	100%	38%	0%
Medium educated/ white collar low											
1,001- 2,000	4%	6%	0%	12%	0%	3%	0%	11%	0%	3%	20%
0,200- 1,000	96%	94%	100%	88%	100%	97%	100%	89%	100%	97%	80%
Low educated/ blue collar high											
0,200- 1,000	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
(b) Skill variables: occupation											
Characteristics	All firms	Industry/ activity				Size			Sector		
Wages defined by skill level		Chemical	Food	Metal	Textile	Large	Medium	Small	Public	Private	Mixed
High educated/ white collar high											
4,001- 5,000	8%	6%	11%	11%	0%	13%	9%	0%	0%	7%	20%
3,001- 4,000	11%	12%	11%	11%	0%	13%	9%	11%	0%	10%	20%
2,001- 3,000	28%	21%	30%	33%	60%	29%	30%	26%	0%	29%	20%
1,001- 2,000	34%	39%	26%	33%	40%	35%	26%	42%	100%	32%	40%
0,200- 1,000	19%	21%	22%	11%	0%	10%	26%	21%	0%	21%	0%
Medium educated/ white collar low											
2,001- 3,000	1%	3%	0%	0%	0%	3%	0%	0%	0%	2%	0%
1,001- 2,000	24%	23%	25%	33%	0%	27%	26%	14%	0%	22%	50%
0,200- 1,000	75%	73%	75%	67%	100%	70%	74%	86%	100%	76%	50%
Low educated/ blue collar high											
1,001- 2,000	6%	4%	9%	13%	0%	3%	10%	7%	0%	7%	0%
0,200- 1,000	94%	96%	91%	88%	100%	97%	90%	93%	100%	93%	100%
Blue collar low											
1,001- 2,000	3%	0%	5%	13%	0%	0%	9%	0%	0%	3%	0%
0,200- 1,000	97%	100%	95%	88%	100%	100%	91%	100%	100%	97%	100%
Others											
4,001- 5,000	2%	0%	4%	0%	0%	0%	5%	0%	0%	2%	0%
0,200- 1,000	98%	100%	96%	100%	100%	100%	95%	100%	100%	98%	100%

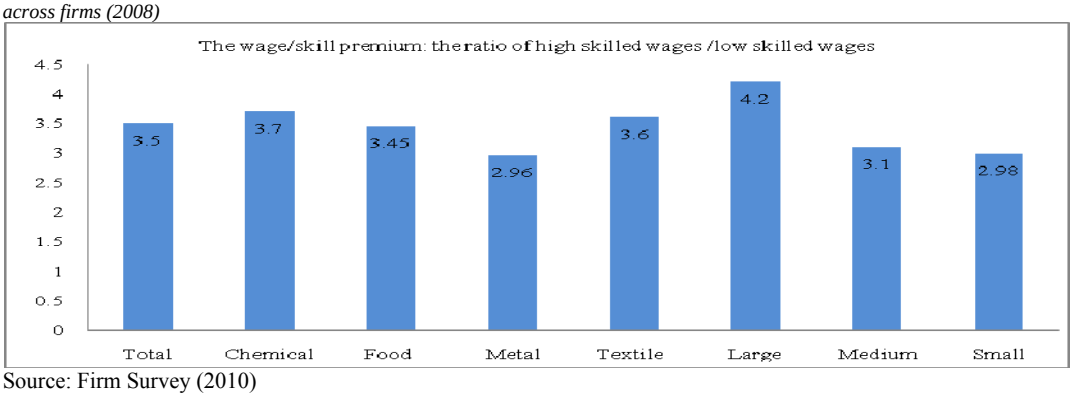
Sources: Firm Survey (2010)

The above results are consistent with the OLS regression reported in Table 13 below, which indicates that the average wages are positively and significantly correlated with and more sensitive to attained/actual education. For instance, Table 10 below illustrates that the average wages are increasing in actual/attained education, experience and its square (cf. Mincer, 1974) and therefore, is biased against less educated and experienced workers. These findings support our results from the firm survey, which indicate that wages are increasing in education and biased against low educated workers because the ratios of high skilled to low skilled wages,

textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

which can be interpreted as wages/skills premium, exceeds one- see Figure 13 below.[65] These results are consistent with the findings in the new growth literature, particularly skilled biased technical change theorems (cf. Aghion and Howitt, 1992; 1998; Acemoglu, 1998; Autor, Katz and Krueger, 1998). Our results from Table 14 indicate that required education also has significant impact on wages are plausible and consistent with our expectation in view of the results of the overeducation literature (Hartog, 2000; Muysken et al. 2001; 2002a;b; 2003). We find that the positive correlations between actual education, experience, its square and wages seem more sensitive to firm size and industry level and are particularly significant for large and medium size firms and chemical and food industries, which may not be surprising since these firms have sufficient scope for a coherent wage policy (Muysken and Nour, 2006). This is also probably because large size and medium size firms and chemical and food industries may have more consistent recruitment strategies and high skill levels – share of high skilled workers in total employment– see Figure 5 above. These results imply that an increase in skill level/actual education and firm size and industry leads to an improved relationship between actual education, experience and wages see Figure 6 above and Table 13 below.

Figure 13 - Differences in wage/skill premium (the ratio of high skilled wages /low skilled wages) defined by education levels across firms (2008)



Source: Firm Survey (2010)

One interesting observation from the firm survey data (2010) and the follow-up interviews with firms' managers and the results presented in Tables 12-14 is that in most cases, the OLS regression results seem to be more significant when using the education definition as compared to occupation definition. This finding seem to be consistent with the observations from Table 12 above but seem to be opposite to the observations from the follow-up interviews and the wide belief among firm's mangers which probably imply that across firms wage's policy is most probably more consistent based on occupation definition instead of education definition.

[65] From the firm survey (2010) we find that the proportion of high skilled wages/low skilled wages accounts for 3.5, 3.7, 3.45, 2.96, 3.6, 4.2, 3.1 and 2.98 for all firms, chemical, food, metal, textile, large, medium and small size firms respectively. We find that the wage premium for Sudan in 2010 is less than the wage premium which we estimated for the large and medium size firms active in the chemical and metal industries in the United Arab Emirates (UAE) in 2002 (Nour, 2005). This result at the micro level is not surprising and it is expected in view of the observed wage differential between Sudan and UAE at the macro level, in particular, this result is consistent with the observed differences in percapita income levels in Sudan and the UAE at the macro level, notably, when using UNDP-HDR (2010) most recent data on per capita income for the year 2008, we realize the low percapita income level in Sudan (US$1,353) as compared to high per capita income in the UAE (US$ 56,485) at the macro level.

This also implies that from firms' perspective the decision of determining wages levels for workers is most probably determined by the nature of jobs that the workers will do in the firms rather than the years of schooling the workers have already obtained. This also most probably implies the positive but weak return and incentives for additional years of schooling to compensate the costs of additional years of schooling. Another interesting observation is that for all groups of firms when using both education and occupation definitions the OLS regression reported in Tables 13-14 below indicate that the correlations between wages levels and years of education variable are more significant as compared to the correlations between wages levels and average years of experience variable. This result implies that the rate of return to the worker's average years of education is higher and more significant than the average years of experience. This finding is also opposite to the observations from the follow-up interviews and the wide belief among some firm's mangers which probably imply that across some firms and from some firm's perspective, the decisions of hiring and offering wages are largely determined by worker's average years of experience which is more important than average years of education for some firms that prefer to hire more experienced than educated workers.

Table 13- Correlation between wages (log) actual and required education and experience (2008) (education definition)

		Coefficient (t-value)					**R^2**	**N[66]**
Independent variable	Group of firms	Actual education	Experience	Experience^2	Required education[67]	Constant		
Dependent variable: Average wages (log)								
Average wages (log) high, medium and low skilled	All firms	0.196** (17.478)				3.948 (27.570)	0.595	73
	Large	0.223** (12.532)				3.663 (16.114)	0.646	26
	Medium	0.178** (9.099)				4.045 (16.121)	0.564	18
	Small	0.178** (8.972)				4.248 (16.838)	0.596	15
	Chemical	0.206 ** (11.742)				3.860 (17.156)	0.605	27
	Food	0.192** (12.131)				3.896 (19.349)	0.657	21
	Metal	0.172** (4.906)				4.591 (10.337)	0.523	7
	Textile	0.197** (5.834)				3.715 (8.668)	0.724	4
	All firms	0.187** (16.398)	0.021** (3.188)			3.951 (27.877)	0.625	70
	Large	0. 221** (11.383)	0.010 (0.866)			3.652 (15.407)	0.653	26
	Medium	0. 161** (9.054)	0.033** (3.674)			4.101 (18.465)	0.675	18
	Small	0.175** (8.582)	0.010 (0.780)			4.225 (16.575)	0.601	15
	Chemical	0. 198** (11.519)	0.023** (2.418)			3.817 (17.268)	0.634	27
	Food	0. 175** (10.097)	0.027** (2.240)			3.976 (19.533)	0.689	21
	Textile	0.219** (9.289)	0.040** (2.228)			3.378 (11.057)	0.912	4
	All firms	0.187** (15.360)	0.024* (1.249)	-0.0001 (-0.156)		3.951 (27.806)	0.625	70
	Large	0.221** (10.626)	0.009 (0.263)	0.00003 (0.18)		3.652 (15.302)	0.653	26
	Medium	0.156** (8.192)	0. 055* (1.924)	-0.001 (-0.792)		4.113 (18.192)	0.678	18
	Chemical	0.195** (10.919)	0.043* (1.397)	-0.001 (-0.687)		3.789 (16.818)	0.636	27
	Food	0.176** (9.783)	0.022 (0.822)	0.000 (0.197)		3.977 (19.396)	0.689	21
	Textile	0.205** (6.546)	0.093 (1.148)	-0.004 (-0.673)		3.433 (10.536)	0.917	4
	All firms	0.153** (6.019)	0.028* (1.360)	-0.0004 (-0.356)	0.038* (1.532)	3.868 (23.996)	0.621	69
	Large	0.172** (4.125)	0.030 (0.808)	-0.001 (-0.482)	0.047 (1.221)	3.579 (13.676)	0.654	26
	Medium	0.126** (2.866)	0.045* (1.420)	-0.001 (-0.384)	0.037 (0.852)	4.018 (15.438)	0.668	18
	Small	0.175** (3.587)	-0.059 (-0.989)	0.004 (1.076)	0.016 (0.314)	4.228 (12.664)	0.614	15
	Chemical	0.162** (4.064)	0.047* (1.360)	-0.001 (-0.725)	0.031 (0.850)	3.791 (14.547)	0.609	27
	Food	0.136** (3.939)	0.024 (0.861)	0.000 (0.100)	0054* (1.545)	3.751 (16.511)	0.718	21
	Textile	0.119* (1.486)	0.104* (1.305)	-0.004 (-0.756)	0.092 (1.172)	3.291 (9.657)	0.931	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

[66] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in section 3 above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[67] The required education is not used as a variable in the upper half of Table 13, because, we want to check the relation with respect to actual/attained education and experience independently and then compare the result when the required education is also included in the regression.

Table 14 – Correlation between wages (log) actual and required education and experience (2008) (occupation definition)

		Coefficient (t-value)					**R^2**	**N[68]**
Independent variable	Group of firms	Actual education[69]	Experience	Experience^2	Required education	Constant		
Dependent variable: Average wages (log)								
Average wages (log) high, medium and low skilled	All firms				0.212 ** (12.176)	3.713 (15.884)	0.429	73
	Large				0.245 ** (13.152)	3.318 (13.061)	0.678	26
	Medium				0.210 ** (7.977)	3.749 (10.636)	0.503	18
	Small				0.204** (7.855)	3.871 (11.500)	0.568	15
	Chemical				0.219 ** (12.130)	3.639 (15.041)	0.637	27
	Food				0.225 ** (9.034)	3.551 (10.662)	0.531	21
	Metal				0.102 (0.904)	5.142 (3.306)	0.036	7
	Textile				0.274 ** (13.055)	2.972 (11.047)	0.929	4
	All firms		0.034** (4.056)		0.189** (10.315)	3.792 (16.074)	0.472	70
	Large		0.023* (1.930)		0.236** (11.832)	3.289 (12.518)	0.688	26
	Medium		0.029** (3.349)		0.190** (7.998)	3.800 (12.120)	0.627	18
	Small		0.040** (2.991)		0.154** (5.231)	4.252 (12.288)	0.625	15
	Chemical		0.025** (3.527)		0.206** (12.160)	3.629 (16.255)	0.691	27
	Food		0.055** (3.683)		0.194** (7.620)	3.641 (11.365)	0.638	21
	Textile		0.018* (1.611)		0.236** (10.982)	3.376 (12.444)	0.950	4
	All firms		0.086** (3.148)	-0.002* (-1.985)	0.172** (8.592)	3.840 (16.322)	0.483	70
	Large		0.088** (2.202)	-0.003* (-1.697)	0.223** (10.538)	3.255 (12.505)	0.699	26
	Medium		0.066* (1.647)	-0.001* (-0.956)	0.173** (5.866)	3.902 (11.772)	0.633	18
	Small		0.069* (1.464)	-0.001 (-0.632)	0.147** (4.649)	4.259 (12.217)	0.628	15
	Chemical		0.079** (3.237)	-0.002** (-2.307)	0.188** (10.297)	3.663 (16.795)	0.710	27
	Food		0.044 (1.025)	-0.000 (-0.269)	0.197** (6.994)	3.631 (11.181)	0.639	21
	Metal		0.271* (1.314)	-0.009 (-0.879)	-0.065** (-0.439)	6.230 (3.585)	0.176	7
	Textile		0.037 (0.850)	-0.001* (-0.455)	0.233** (10.042)	3.344 (11.360)	0.951	4
	All firms	0.132** (3.658)	0.062** (2.281)	-0.001* (-1.344)	0.068* (1.964)	3.637 (15.526)	0.519	70
	Large	0.193** (4.969)	0.031 (0.838)	-0.001 (-0.720)	0.076** (2.183)	3.013 (12.983)	0.775	26
	Medium	0.111** (2.169)	0.063* (1.612)	-0.001 (-0.979)	0.076* (1.449)	3.794 (11.698)	0.663	18
	Chemical	0.120** (3.710)	0.056** (2.364)	-0.001* (-1.559)	0.097** (3.243)	3.434 (16.206)	0.753	27
	Textile	0.080 (1.161)	0.019 (0.417)	-0.0003 (-0.145)	0.163** (2.519)	3.337 (11.611)	0.960	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

[68] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in section 3 above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[69] The actual/attained education is not used as a variable in the upper half of Table 14, because, we want to check the relation with respect to required education and experience independently and then compare the result when the actual/attained education is also included in the regression.

Therefore, our findings in this section corroborate the first part of the second hypothesis that an increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages. In the next section we proceed to examine the second part of the second hypothesis that an increase in skill levels and firm size lead to improved relationships between skill, upskilling and technology (ICT). Finally, we test our third hypothesis on the relationship between technology (ICT) and input-output indicators at the micro/firm level.

6 Skill, upskilling (ICT training), technology (ICT) and input-output indicators

Based on the above results, in this section we examine the other part of the second hypothesis that an increase in skill levels and firm size lead to improved relationships between skill, upskilling and new technology (ICT) across firms. Before examining this hypothesis, it is useful to briefly show the variations in the use of new technology (spending on ICT) and upskilling (spending on ICT training) across firms, because the observed differences in skill and spending on ICT and ICT training can be used to interpret the complementary relationships between skill, technology and upskilling across firms.

6.1 Skill and the share of spending on technology (ICT) and upskilling (ICT training)

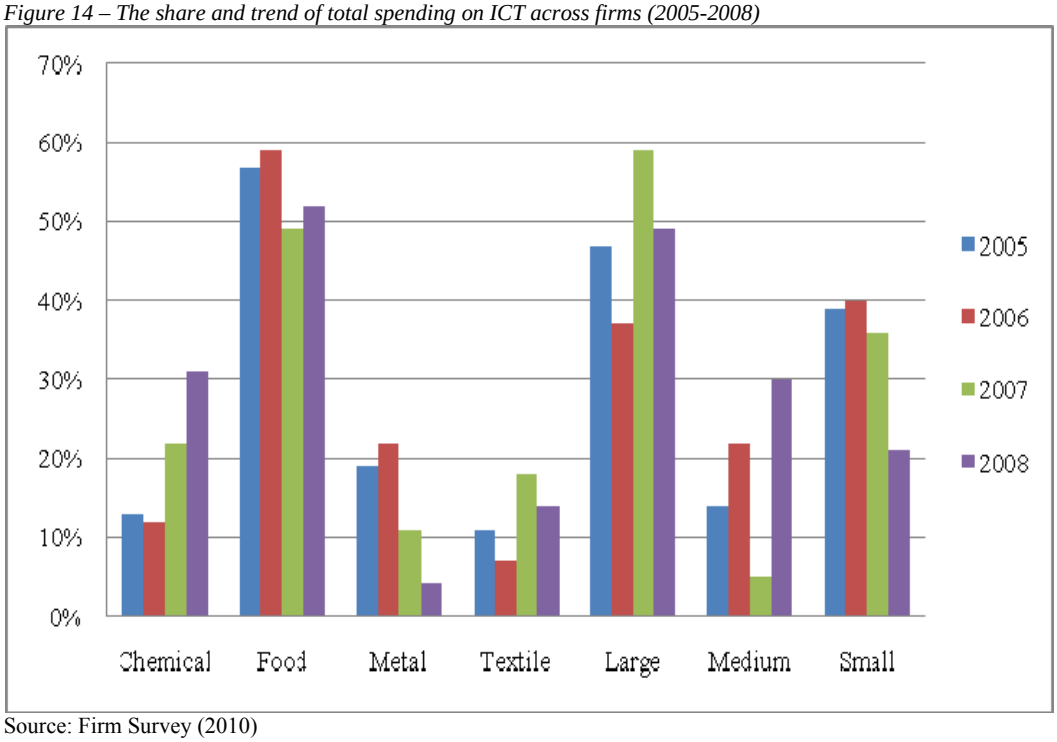
Table 15 shows considerable variations in the share and trend of total spending on ICT including computers, telecommunications, training, internet, maintenance and other items defined by firm size and industry. The share of telecommunication exhibits continuous increasing trend for all firms, while that of training shows an opposite declining trend. Table 5 above shows that, on average, the share of large size and food and chemical firms represents about 48%, 53% and 23% of total spending on ICT respectively and about 75%, 73% and 2% of total spending on ICT training respectively. However, despite the big share of spending on ICT and ICT training, large size and food firms experienced declining trends of ICT and ICT training - cf. Figures 14-15. The decline in total ICT spending can be interpreted as being due to a lack of plan for critical expansion in ICT sector or probably due to a general cutback in total spending across food and large size firms. The declining expenses on both ICT training and computers follow the general decline in total ICT spending, which can also be attributed to a lack of plan for critical expansion and a possible change in the strategy of firms that, having already established a sound basis for these components, probably need to shift priority to increase spending on both telecommunications and maintenance.

Table 15 – Spending on ICT defined by firm size and industry (2005-2008) (% share in total spending)

Share in total spending in ICT (%) (2005-2008)	Group of Firms/ Years	Industry/activity				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Share in total spending in computer (%)	2005	16%	48%	13%	23%	28%	29%	43%
	2006	15%	55%	14%	16%	35%	22%	43%
	2007	32%	45%	9%	14%	50%	6%	45%
	2008	46%	42%	2%	9%	53%	27%	20%
Share in total spending in telecommunication (%)	2005	17%	55%	24%	3%	51%	5%	44%
	2006	13%	64%	21%	2%	24%	31%	44%
	2007	26%	52%	9%	12%	50%	9%	41%
	2008	29%	62%	3%	7%	32%	42%	26%
Share in total spending in training and software development (%)	2005	0%	100%	0%	0%	97%	0%	3%
	2006	0%	84%	16%	0%	79%	16%	5%
	2007	3%	83%	0%	15%	93%	0%	7%
	2008	3%	82%	0%	15%	82%	6%	12%
	2005-2008	2%	73%	12%	13%	75%	18%	7%
Share in total spending in internet (%)	2005	25%	26%	50%	0%	25%	0%	75%
	2006	19%	24%	53%	4%	19%	4%	76%
	2007	15%	37%	26%	21%	57%	0%	43%
	2008	10%	41%	11%	38%	57%	23%	21%
Share in total spending in maintenance services (%)	2005	3%	3%	94%	0%	3%	0%	97%
	2006	17%	1%	81%	0%	15%	21%	64%
	2007	6%	1%	33%	61%	61%	0%	39%
	2008	5%	13%	24%	59%	59%	14%	27%
Share in total spending in hosting and other relevant ICT services (%)	2005	1%	99%	0%	0%	100%	0%	0%
	2006	0%	99%	0%	0%	95%	0%	5%
	2007	0%	41%	0%	59%	98%	0%	2%
	2008	4%	28%	0%	67%	94%	4%	1%
Share in total spending in ICT (%)	2005	13%	57%	19%	11%	47%	14%	39%
	2006	12%	59%	22%	7%	37%	22%	40%
	2007	22%	49%	11%	18%	59%	5%	36%
	2008	31%	52%	4%	14%	49%	30%	21%
	2005-2008	24%	53%	11%	13%	49%	22%	30%
Share in average total spending in ICT (%)	2005-2008	23%	53%	11%	13%	48%	21%	30%
Numbers of respondents	54	27	16	6	5	20	18	16

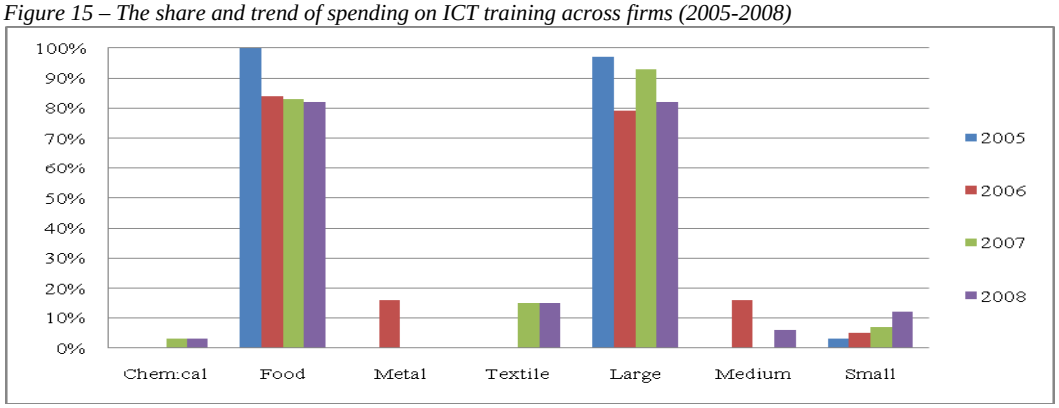
Source: Firm Survey (2010)

Figure 14 – The share and trend of total spending on ICT across firms (2005-2008)



Source: Firm Survey (2010)

Figure 15 – The share and trend of spending on ICT training across firms (2005-2008)



Source: Firm Survey (2010)

We now proceed to examine the second part of our second hypothesis that an increase in skill levels and firm size leads to improved complementary relationships between skill, technology (ICT) and upskilling (ICT training)– see Table 16 below. For instance, we observe the complementary relationship between the share of high education and the share of expenditure on ICT, which can be seen and understood as complementarity between skill and technology (cf. Goldin and Katz, 1998; Acemoglu, 1998). We find a complementary relationship between the share of high education and the share of expenditure on ICT training, which can be interpreted as complementarity between skill and upskilling. Tables 16-17 show complementary relationships between the share of expenditure on ICT and ICT training, and between spending on computers, telecommunications, internet and training, which can be read as complementarity between technology and upskilling (cf. Colecchia and Papaconstantinou, 1996; Bresnahan and Hitt, 1999). Our findings, that these complementarities are particularly significant for large size firms, are plausible since these firms have more spending on ICT and ICT training – see Table 5 above – and have high skill levels – share of high skilled workers in total employment – see Figure 5 above. These results are consistent with the second part of our second hypothesis that an increase in skill levels and firm size lead to improved complementary relationships between skill, upskilling and technology (ICT) (cf. Acemoglu, 1998). The results also imply the importance of a good education/high skill level for the enhancement of skill, technology and upskilling complementarity at the micro level. That also seems consistent with the endogenous growth framework and stylized facts concerning the relationships between human capital, technical progress and upskilling discussed in the new growth literature.

Table 16 - The relationship between ICT, skill and upskilling across firms (2008) (2005-2008)

		Coefficient	**(t-value)**		**R^2**	**N**
Independent variables		ICT expenditures	Training expenditures	Constant		
Dependent variables	Group of firms					
High education (linear)	All firms (linear) (1)	0.002* (1.385)		0.344 (14.420)	0.014	34
	All firms (linear) (2)			30.963 (6.770)	0.023	44
	All firms (linear) (2)	0.003** (2.115)		31.724 (10.198)	0.052	82
	Chemical (linear) (2)	0.003* (1.241)		33.111 (7.354)	0.042	36
	Food (linear) (2)	0.002* (1.200)		29.619 (5.387)	0.051	28
	Metal (linear) (2)	0.001 (0.764)		31.684 (3.186)	0.055	11
	Textile (linear) (2)	0. 001** (4.773)		19.140 (3.175)	0.884	4
	Large (linear) (2)	0.006** (2.440)		23.384 (2.740)	0.351	13
	Large (linear) (2)	0.005** (2.349)		26.992 (3.796)	0.283	16
	Medium (linear) (2)	0.004* (1.953)		27.875 (6.103)	0.128	27
	All firms (linear) (1)		0.001** (2.309)	0.3123 (4.765)	0.262	15
ICT(linear: 2005-2008)	All firms (linear) (1)		1.746** (4.827)	15135109 (2.830)	0.608	6
Training expenditures	All firms (linear) (1)	0.349** (4.827)		-1905361 (-0.653)	0.608	6
	All firms (linear) (2)	0.054 (0.485)		4407619.75 (0.680)	0.045	6
	Large (linear) (2)	0.473** (2.301)		-3989610.8 (-0.536)	0.726	3
	Food (linear) (2)	0.036 (0.229)		5907673.03 (0.565)	0.017	4
	All firm (log) (2)	1.018** (5.218)		-1.077 (-0.762)	0.845	6
	Large (log) (2)	1.258** (9.317)		-2.597 (-2.750)	0.977	3
	Food (log) (2)	1.046** (4.627)		-1.399 (-0.851)	0.877	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)
Note: (1) (2005-2008), (2) 2008.

Table 17- The relationship between computers, training, internet and telecommunications expenditures across firms (2005-2008)

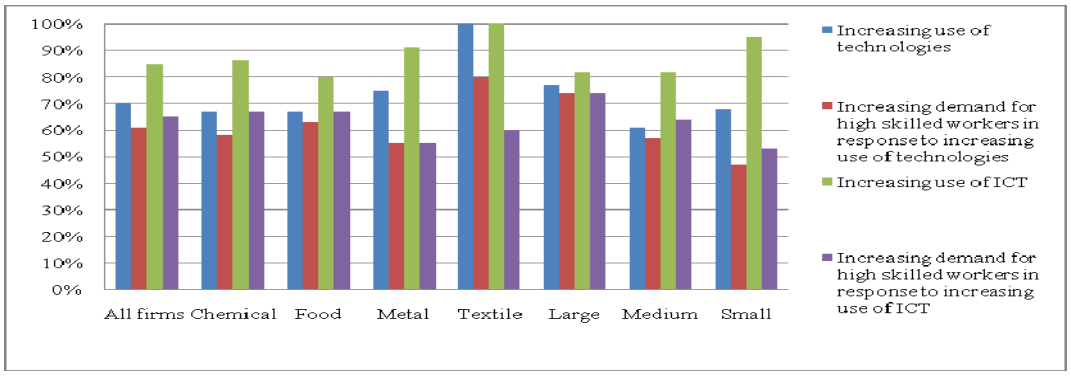
		Coefficient(t-value)					R^2	N
Independent variables		Computer expenditure	Training expenditure	Telecommunication expenditure	Internet expenditure	Constant		
Dependent variables (All firms)								
Computer expenditure : All firms	2005			1.587** (6.836)		748133.60 (0.980)	0.745	17
	2005		0.571** (2.687)			3059520.92 (0.958)	0.783	3
	2006			0.367** (4.410)		241933.61 (0.333)	0.506	20
	2006		0.865** (2.229)			3153599.66 (0.530)	0.713	3
	2007		0.147 (0.540)	0.981** (2.008)		-969394.91 (-0.241)	0.674	5
	2008		-0.001 (-0.002)	1.129** (4.445)		-2508705.42 (-0.391)	0.832	6
	2008			1.136** (7.319)		376032.41 (0.218)	0.579	40
	2008		-0.104 (-0.114)			15637070.23 (1.450)	0.003	6
	2005-2008			0.763678** (8.536810)		1435747 (2.370763)	0.450	36
	2005-2008		0.247* (1.523)	1.023** (6.353)		165382.95 (0.063)	0.741	6
	2005-2008				1.128** (3.160)	2952505 (2.484)	0.169	23
	2005-2008			0.780** (6.971)	0.458* (1.684)	1312687 (1.493967)	0.587	23
Training expenditure : All firms	2005	1.370** (2.687)				-2505285.03 (-0.439)	0.783	3
	2005			3.054** (22.081)		-676083.74 (-0.973)	0.996	3
	2006	0.824** (2.229)	0.067 (0.044)			138622.51 (0.022)	0.713	3
	2007	0.601 (0.540)				2443767.60 (0.303)	0.236	5
	2005-2008	0.512* (1.523)		-0.416 (-0.986)		5907509.77 (1.708)	0.140	6
	2005-2008	0.001* (1.252)				12.94005 (14.723)	0.125	5
Telecommunication expenditure : All firms	2005	1.379** (4.410)				1752340.80 (1.294)	0.506	20
	2005		0.326** (22.081)			231759.71 (1.046)	0.996	3
	2007	0.584** (2.008)	0.010 (0.044)			2754897.90 (1.023)	0.642	5
	2008	0.510** (7.319)				2032297.91 (1.828)	0.579	40
	2008		-0.092 (-0.125)			16072454.82 (1.845)	0.003	6
	2008	0.737** (4.445)	-0.015 (-0.044)			4553581.73 (0.956)	0.832	6
	2005-2008	0.589516** (8.536810)				758843.9 (1.398)	0.450	36
	2005-2008				0.896** (2.936)	1864490 (1.921)	0.138	23
	2005-2008	0.700** (6.353)	-0.138 (-0.986)			2203956.51 (1.054)	0.721	6
	2005-2008	0.645** (6.971)			0.132 (0.520)	197942.2 (0.242)	0.565	23
Internet expenditure : All firms	2005-2008	0.150** (3.160)				1058449 (2.436)	0.169	23
	2005-2008	0.122* (1.684)		0.043 (0.520)		1044110 (2.380526)	0.174	23
	2005-2008			0.154** (2.936)		1142708 (2.968)	0.138	23

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

6.2 The use of technology, ICT, skill and the demand for skilled workers across firms

One implication of the above complementary relationship between skill and technology is that the demand for skilled workers has changed in response to the increasing uses of ICT and other technologies. For instance, during the period 2006-2008 the uses of ICT (85%) increased faster than that of other technologies (70%); similarly, the corresponding rise in the demand for skilled workers needed for ICT (65%) was more than that for other technologies (61%) across all respondents firms – see Figure 16 below. This trend may reflect the fact that the real demand for skilled workers needed for ICT is more than that of other technologies across firms, which may not be surprising given the recent rapid increasing trend of IT diffusion despite the recent history of IT diffusion in the Sudan. For instance, according to the World Development WDI Data base (2005), before 2000 the number of users of both mobile phone and internet per (1,000 population) were zero, up till the year 2000 both were only one, in the recent years, Sudan shown a growing telecommunication network and internet services but still the highest price/most expensive internet services as compared to other African and Arab and developing countries.

Figure 16- The increasing use of technology, ICT and the demand for high skilled workers across firms, 2006-2008



Source: Firm survey (2010)

According to the respondent firms, the increasing use of new technologies caused an increase in both the demand for more skilled workers and the required skill levels of the respective workers involved with them. Table 18 indicates that the increasing use of new technologies has important effects on increasing the general skill levels and the demand for skilled workers amongst 88% and 83% of the respondent firms respectively.[70] However, it has relatively less important effects on increasing skill levels mainly for unskilled workers, and decreasing and substituting the demand for unskilled workers due to reduction and elimination/substitution of some unskilled jobs. This implies change in the structure of employment/demand for workers

[70] Firms reported the use of different types of new technologies such as mass chemicals plants, advanced process controls, food processing machines and plants installation, CNC machines, new advanced machines and ICT.

in response to the increasing uses of new technologies and is also evidence of skilled-biased technical change theorem.[71]

Table 18 - The effects of new technologies on skill level and the demand for workers in the Sudan, 2008

The effects of new technologies in:	All firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Increasing the general skill level.	88%	94%	92%	64%	80%	91%	88%	89%
Increasing the demand for skilled workers (more educated, trained and experienced workers).	83%	82%	81%	82%	100%	84%	88%	72%
Increasing skill level mainly for unskilled workers.	79%	85%	65%	82%	100%	84%	76%	72%
Reduction in some unskilled jobs	79%	85%	80%	60%	80%	88%	76%	76%
Increasing the demand for more professional workers	76%	76%	77%	82%	60%	72%	80%	78%
Decreasing the demand for less skilled workers (less educated, trained and experienced workers).	74%	79%	65%	73%	80%	81%	72%	67%
Decreasing the demand for production workers.	68%	68%	69%	64%	80%	84%	56%	56%
Elimination/ substitution of some unskilled jobs	65%	68%	69%	50%	60%	75%	52%	71%
Substituting the demand for less skilled workers.	57%	53%	58%	55%	80%	69%	44%	50%
Total response	76	34	26	11	5	32	25	18

Source: Own calculation based on the firm survey (2010).

Moreover, from the firm survey we find that the increasing use of new technologies has not only raised the demand for high skilled workers in the past years, but also encouraged firms to predict a future/ long run increase in the demand for high skilled workers. For instance, for 68% of the respondent firms the interpretations of the predicted long run increase in the demand for skilled workers are related to planned/expected expansion of production, product diversification, implementation of new process, output technologies, purchases of new machines and equipment and increasing R&D activities.[72] This result seems consistent with the assumption made by Aghion and Howitt (1992) that an expectation of more research in the next period must correspond to an expectation of higher demand for skilled labour in research in the next period.

6. 3 The share of spending on ICT and input-output indicators

Finally, in this section we investigate the third hypothesis on the positive relationships between new technology (total expenditures on ICT) and input-output indicators across firms and over time. For instance, when investigating the relationship between ICT and input variables, we find from Tables 19 that the total spending on ICT is positively correlated and more sensitive to labour (firm size), and industry level throughout the period 2005-2008 and also become sensitive to capital (net worth), notably, throughout the period 2007-2008. Both the total spending on ICT and ICT training (upskilling) are positively and significantly correlated and more sensitive to labour (firm size), and capital (net worth) throughout the period 2005-2008. The relationship between ICT and labour (firm size) is particularly more significant for the large size, chemical and textile firms. The different results across chemical and textile or large

[71] This result is consistent with SBTC theorem and our earlier findings indicating that wages are increasing in education and biased against unskilled workers.

[72] Moreover, other factors are: the expected increases in market share, turnover, sales, adoption of international standards and enhancement of production, advanced control systems, shortage of manpower, competition, increasing motivation to reduce

size firms is plausible and can be attributed to differences in the skill levels – share of high skilled workers in total employment – see Figure 5 above. This is also because large size firms are more prevalent in the textile and chemical industries, they have high share in total ICT spending, employment, fixed capital, value added and profit – see Table 5 above – and probably have more consistent entrepreneurial/organizational strategies.

Table 19– Total spending on ICT, labour and capital across firms (2005-2008)

		Coefficient (t-value)			R^2	N
Independent variables		Labour	Capital	Constant		
Dependent variable (ICT expenditures)						
ICT expenditures	All firms (2008)	31189.873** (2.068)		4017773.618 (1.286)	0.090	44
	Large	39678.002* (1.801)		659819.035 (0.091)	0.178	16
	Small	851008.625* (1.350)		-17122964.336 (-0.871)	0.132	13
	Chemical	16570.802* (1.261)		1352016.355 (0.482)	0.077	20
	Food	114796.261 (1.194)		2209388.184 (0.205)	0.106	13
	Textile	41167.945* (1.749)		6311339.471 (0.678)	0.505	4
ICT expenditures (All firms) (log)[1]	2005	50597.659** (2.047)	0.00003 (0.624)	200891.316 (0.051)	0.173	23
	2006	48260.393* (1.636)	0.00001 (1.113)	1868612.501 (0.425)	0.132	26
	2007	30134.482* (1.906)	0.00001** (2.779)	1535671.553 (0.525)	0.266	31
	2008	34994.538** (2.707)	0.00002** (5.597)	2453825.412 (0.941)	0.525	35
ICT expenditures (All firms) (log) (2005-2008)	Total ICT (log)	0.007** (3.196)	0.002** (3.514)	10.770 (24.801)	0.166	36
	Training (log)	0.03** (4.714)	0.002** (3.791)	6.648 (4.155)	0.655	5
	Computer (log)	-0.011* (-1.649)	0.002** (3.227)	11.516 (17.591)	0.167	30
	Telecommunication (log)	-0.004* (-1.434)	0.002** (3.02)	10.949 (24.147)	0.127	34
	Internet (log)	-0.001 (-0.145)	0.001 (1.134)	11.170 (12.641)	0.0394	17
	Maintenance (log)	0.006 (0.631)	0.0004 (0.577)	9.596 (7.641)	0.0271	11
	Other (log)	-0.008 (-0.745)	0.0002 (0.222)	11.417 (9.707)	0.0426	6

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)
Note: (1) Log value for all estimated variables: ICT, labour and capital.

We examine the relationship between new technology measured by total spending on ICT, profit and output. Table 20 illustrates plausible positive thought not significant correlations between new technology measured by total spending on ICT, capital labour, and total output -measured by total sales value, output diversification -measured by sales diversification, productivity -measured by total sales value/labour ratio, and positive significant correlations between new technology measured by total spending on ICT and profit and value added over the period 2007-2008.[73] In addition to positive significant correlations between old technology measured by total spending on machinery and equipment and total output measured by total

costs, achieving high standard precision work, improving productivity, quality of work and demand for more specialized skills in IT.

[73] Except in 2008, where the correlations between labour and profit, labour, capital, productivity and diversification are negative.

sales value, profit and value added, between value added and old technology measured by total spending on machinery and equipment, spending on raw materials and capital. For old technology measured by total spending on machinery and equipment, the correlation coefficients are more significant than traditional inputs (labour-capital) over the period 2005-2008. These results prove our third hypothesis regarding the positive correlation between ICT and input-output indicators at the micro/firm level. However, our results should be interpreted carefully as they probably have two-ways causality and may leave open the possibility for reversed causality. Mainly because more profit and output would imply more financial capacity that permits more spending on ICT, on the other hand, more spending on ICT implies higher costs and lower profit- see Table 20 below.

Our findings concerning the significant positive correlations between ICT and profit and value added and the insignificant correlation between ICT and output imply an inconclusive effect at the micro level. These results agree with our observations at the aggregate level, which imply that the growing expenditures on ICT in the Sudan raises the shares of the population using the Internet, enhances e-business, e-education and e-government. However, despite the growing ICT expenditures, their effects are inconclusive at the aggregate level, probably due to low spending on ICT, high poverty and illiteracy rates, low skill levels and inadequate investment in education.[74] The macro observations are consistent with the recent literature indicating the growing but limited effects of ICT diffusion in the developing countries due to a lack of sufficient investment in the complementary infrastructure such as education, skills and technical skills (cf. Pohjola, 2002; Kenny, 2002). Therefore, these results prove the third hypothesis in Chapter 1 above about the inconclusive effect of ICT at the micro level.

[74] Our attempt to examine the effect of ICT at the macro level in Sudan is constrained by the lack of adequate and reliable data on ICT spending as the most recent data on the share of spending on ICT relative to GDP (2010) is available only for two years over the period (2007-2008).

Table 20– The correlation between, firm performance, output and profit and labour, capital, total spending on ICT, machinery and equipment and raw materials across firms across firms, (2005-2008)

		Coefficient (t-value)						R^2	N
Independent variables		Labour	Capital	Total spending on ICT	Total spending on machinery and equipment	Total spending on Raw materials	Constant		
Dependent variables All firms									
Total output (total sales value) [1]	2005[1]	0.624 (0.729)	0.196 (1.112)				9.935 (2.024)	0.077	22
	2005[1]			0.097 (0.356)			14.828 (4.497)	0.006	23
	2006[1]	0.748 (0.812)	0.253* (1.526)				8.728 (1.755)	0.110	25
	2006[1]			0.103 (0.464)			14.864 (5.346)	0.008	27
	2007[1]	0.126 (0.167)	0.222* (1.502)				11.509 (2.638)	0.075	30
	2007[1]			0.185 (0.915)			13.847 (5.583)	0.025	34
	2008[1]	0.095 (0.142)	0.193* (1.403)				12.508 (3.091)	0.059	34
	2008[1]			0.154 (0.913)			14.566 (6.965)	0.021	40
	(2005-2008) [1]	0.349 (1.047)	0.337** (5.046)	0.075 (0.845)			8.220 (4.387)	0.244	35
	(2005-2008) [1]	0.003* (1.328)	-0.0005 (-0.869)		0.006** (4.210)		16.195 (36.991)	0.154	35
Profit[1]	2005[1]	0.553 (0.576)	0.416** (2.448)	0.119 (0.488)			4.111 (0.806)	0.419	15
	2006[1]	0.890 (1.076)	0.441** (3.384)	0.040 (0.214)			3.350 (0.769)	0.480	19
	2007[1]	0.450 (0.660)	0.433** (3.910)				5.095 (1.408)	0.392	26
	2007[1]			0.273* (1.281)			11.891 (4.498)	0.055	29
	2008[1]	-0.190 (-0.359)	0.291** (2.270)	0.117 (0.818)			9.277 (2.905)	0.312	28
	2008[1]			0.300* (1.854)			11.740 (5.820)	0.097	33
	(2005-2008) [1]	0.001 (0.280)	0.0001 (0.715)	0.0001 (0.352			14.615 (29.834)	0.013	34
	(2005-2008) [1]	0.003 (1.124)	0.0007* (1.278)		0.001** (4.558)		14.213 (34.225)	0.203	33
Value added [1], [2]	2005[1]	0.700 (1.026)	0.335** (2.430)				7.482 (1.884)	0.256	21
	2005[1]			0.205 (0.883)			13.820 (4.806)	0.039	20
	2006[1]	0.568 (0.839)	0.328** (2.694)				8.278 (2.225)	0.267	23
	2006[1]			0.076 (0.426)			15.249 (6.948)	0.008	24
	2007[1]	0.307 (0.467)	0.427** (3.384)				7.164 (1.887)	0.306	28
	2007			0.439** (2.122)			10.936 (4.347)	0.143	28
	2008[1]	0.363 (0.620)	0.399** (3.399)				7.482 (2.085)	0.286	31
	2008[1]			0.275* (1.561)			12.922 (5.994)	0.071	33
	(2005-2008) [2]	246591.7 (0.609)	0.02** (2.529)		0.0154** (4.064)	0.159** (13.050)	-82886294 (-1.441)	0.981	18
Diversification (sale diversification)	2008[1]	-0.073 (-1.137)	-0.013 (-0.937)	0.014 (0.832)			0.677 (1.798)	0.056	34
Productivity (Sale/labor)	2005-2008[1]	-0.004 (-1.450)	-0.0001 (-1.068)	0.0002 (0.947)			12.36 (26.760)	0.027	35
Total spending on Machinery and equipment	(2005-2008) [1]		0.514** (5.195)				7.631 (4.437)	0.465	32
Wage[1]	(2005-2008) [1]	0.395* (1.534)	0.445** (9.171)				6.080 (4.167)	0.431	35

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)
Note: (1) Log value for all estimated variables, (2) linear

7 Conclusions

In this chapter we use the data from the firm survey (2010) to examine skill indicators, their implications and relationships with average wages, and with upskilling (ICT training) and technology (ICT), ICT and input-output indicators at the micro/firm level.

Our findings in Section 4 illustrate the low skill levels –due to the excessive share of unskilled workers (Figures 6-7) – and the implications on skills mismatch (Figure 11), industrial performance indicators and productivity decline across firms (Tables 6-9). These results are consistent with the micro-macro findings in Nour (2011), which indicate the low share of high skilled in total population and employment – measured by both educational and occupational levels – and the serious implications on skills mismatch and the macro-micro duality with respect to upskilling efforts. These findings together with those in Nour (2011) verify our first hypothesis in section 1 above regarding the implications of the high use of unskilled workers. These findings then confirm our first hypothesis, which we proved in Nour (2011), concerning the pressing need for upskilling, particularly within the private sector. We find that the performance of the industrial firms is most probably significantly undermined by the shortage of skilled workers and also by the lack of entrepreneur perspective.

Our results in Section 5 show positive correlations between actual and required education, experience and average wages (Tables 11-14). We verify our second hypothesis in section 1 above that an increase in skill level and firm size lead to improved relationships between actual and required education (Table 11), between actual education, experience and wages (Table 13) and between required education, experience and wages (Table 14).

In Section 6 our findings with respect to the positive complementary relationships between skill, technology (ICT) and upskilling (ICT training) and between computers, telecommunications and ICT training (Tables 16-17) are consistent with the findings in the new growth literature. We illustrate and corroborate our second hypothesis in section 1 above that an increase in skill level and firm size lead to an improvement in the complementary relationships between skill, upskilling and technology (ICT).

Taken together, all these results imply the importance of a good education for bridging differences between firms and also for enhancing skill, technology and upskilling complementarity at the micro level. These findings seem consistent with the endogenous growth framework and stylized facts concerning the relationships between human capital, technical progress and upskilling and endogenous growth literature.

Finally, our results in Section 4 indicate positive significant correlations between total spending on ICT and profit and value added, but insignificant correlations between total spending on ICT and output at the micro/firm level (Table 20). This result confirms the third hypothesis in section 1 above, which implies an inconclusive effect of ICT at the micro level

and supports the observations at the macro level in the Sudan and the recent literature in the developing countries.

Moreover, our results in Sections 5 and 6 show the relationships between actual and required education, experience and wages; and between skill, technology (ICT) and upskilling (ICT training) defined by firm size and industry level. These results are consistent with our findings in Nour (2011), which imply that both skill and technology indicators vary across firms and increase with firm size and industry level.

Therefore, our findings in this paper verify our first hypothesis in section 1 above with respect to the implications of the excessive use of unskilled workers at the micro level. In addition, our results verify our second hypothesis in section 1 above concerning the relationships between actual and required education and experience and between actual education, required education, experience and wages and the relationships between technology (ICT), skill and upskilling (ICT training). Finally, we corroborate the third hypothesis in section 1 above regarding the inconclusive effect of ICT at the micro level.

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